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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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Scientific Worthies.

XLII.—HENDRIK ANTOON LORENTZ.

THE outstanding leader in physical science who is the subject of this notice was born at Arnheim in Holland on July 18, 1853, graduated at Leyden in 1875, became Professor of Mathematical Physics at that University as early as 1878, discharged the duties of that Chair with great brilliancy until his appointment a few years ago to the direction for research in the historical Teyler Institute at Haarlem, leaving Ehrenfest as his successor. He retains his connexion with Leyden as Honorary Professor, and does not treat that position as a sinecure : the weekly lecture delivered by him, and usually reported for publication by members of his audience, is one of the outstanding events in the University life. At Haarlem he leads the philosophic life, enjoying the society of his grandchildren, controlling the physical side of the Institute, which is also famous on the artistic side for the collection of the great local painter Franz Hals. The jubilee of his doctorate on December 11, 1900, was commemorated by the presentation of a volume of researches contributed by most of the notable cultivators of physical science in the world.

Since the middle ages the Low Countries have always been a seat of fervent and productive intellectual activity. In early times they were conspicuous for a broadening of the Catholic theological learning in the direction of humanism. Later, in the congenial soil provided by the achievement of ordered political liberty, they became a focus of Protestant learning, which under the stimulus of free controversy broadened out into the domains of Jurisprudence and Polity. Holland was the peaceful refuge of students such as Descartes and Spinoza : its free press played a principal part in the spread of learning in Europe, and was even the means of original publication of some of the writings of Galileo. In physical science Huygens was one of an illustrious international company which included his contemporary Newton, and ranks next among his peers both in dynamics and in optics. In our own days the eminence of Holland in physical science is maintained by H. A. Lorentz, H. Kamerlingh Onnes, P. Zeeman, and others of a brilliant band who have been, in the main, products of the great University of Leyden which dates from the times of national revival.

In his early days contemporaries in this country to whom Dutch sources were not very accessible owed their knowledge of Prof. Lorentz's writings mainly to expositions and discussions by a kindred spirit the late Lord Rayleigh, and subsequently by Lodge in connexion with his thorough experimental scrutiny of the relation of the Earth's motion to the aether, regarded as the seat of propagation of the rays of light by which we explore the universe. No trace could be anywhere found of exception to the principle that Lorentz favoured as the basis of optical theory, that the aether is a stationary medium: material bodies must thus be structures of molecular texture so open that, in the simile of Thomas Young when he pleaded in 1800 for a revival of the wave theory of Huygens, the aether penetrates through moving matter as freely as the wind through a grove of trees. The republication of some of Prof. Lorentz's early investigations, in which historical exposition and criticism are so happily blended with new advance, in vol. i. of his "Abhandlungen über theoretische Physik" in 1907 revealed, at any rate to one student, how much research into sources might have been saved him by earlier access to the *Archives néerlandaises* of 1887.[1] The volume also presented much unpublished material. There is for example a treatise on the Second Law of Thermodynamics and its relation to Molecular Theory, pp. 202-298. Nothing could be more valuable, for students who desire a real grasp of this fascinating subject, than connected exposition by a master, on general lines freed from excursions into detail.

This work was doubtless even fresher then than now, when the principles the scope of which is so universal have been sifted and refined in all directions in so many essays and text-books. The power and simplicity of the foundations of pure thermodynamics have at all times been a magnet to the most powerful minds, from Kelvin who persisted with the prescience of genius in hunting out and rediscovering in Paris the master tract of Sadi Carnot, down through Clausius, Maxwell, Helmholtz, Willard Gibbs. One can recall the crucial fundamental concept of Available, in contrast with Dissipated, Energy, introduced in a fragmentary way by Kelvin, whose wealth of fresh thoughts and of practical interests scarcely ever allowed him a chance of systematically developing any subject; its relation to the more convenient analytical concept of Entropy introduced by Clausius, and its physical elucidation in terms of a science of molecular statistics by Boltzmann and Gibbs; the luminous expositions and developments of Rayleigh; the theoretical outlook of Gibbs, vast enough to predict a full-blown new science of Physical Chemistry before it had come to birth; even such questions of pure logic as the intimate essential connexion of the principle of Carnot with the identification of heat as energy which came finally twenty years later. One remembers a remark of Prof. Lorentz in relation to an obituary exposition of Kelvin's early activity, that he had not been aware that this side of the subject had been so fully grasped at that early date.

In this historical feeling which has led Prof. Lorentz so frequently to interweave his own contributions to knowledge into a reasoned analysis of the actual position of the science at the time, close affinity may be traced with the work of Lord Rayleigh. For both of them, perhaps especially for the latter, an essential interest of human learning is the story of its historical evolution: nothing is so attractive as to recognise, still more to discover, the early insight of genius into problems usually thought to belong to later times. To both of them it appears to have been at least as congenial to explore and improve a wide field of knowledge, as to engage in strenuous special calculations such as are the very essence of progress in dynamical astronomy: though neither of them shirked such tasks when they presented themselves. Perhaps nowadays appreciation of the past is more than ever necessary to balance the haste of the present.

Of late years Prof. Lorentz's activity has been much turned by public demands into the direction of formal courses of lectures at University centres, in which his own thoughts and ideas are happily embedded. Thus the standard treatise on the Theory of Electrons arose out of lectures at Columbia University, New York, in 1905; several courses have been published in German; and a most interesting and concise reasoned account of the state of knowledge and speculation regarding statistical thermodynamic theories, leading up through Brownian movements and local fluctuations of energy into the mysteries of quanta, delivered at the Collège de France in 1912, came to be issued in French from Leipzig with additional notes in the year 1916. Earlier discussions on this latter subject (Abhandlungen, vol. i.) followed the lines developed also

[1] "Influence du mouvement de la terre sur les phénomènes lumineux": Abhandlungen, i. pp. 341-394.

H. A. Lorentz

by Maxwell, Boltzmann, Rayleigh, Gibbs, which originated this domain of knowledge and, though now beset with fundamental experimental difficulties, are still the ultimate foundation of our ideas. The articles "Maxwells Electromagnetische Theorie" (June 1903) and "Elektronentheorie" (December 1903) in the Mathematical Encyclopædia are standard treatises.

His doctor's dissertation (1875) was a treatise (177 pp.) on the reflection and refraction of light, which was abstracted at considerable length by E. Wiedemann in his *Beiblätter*, vol. i., 1887. Proceeding from Helmholtz's form of the Maxwell theory, it develops a hint contained in a footnote in Helmholtz's first memoir, that the interfacial conditions of the electric theory are precisely those that lead naturally to Fresnel's standard laws of reflection. Transmission in metals also comes under review, and the laws of reflection from their surfaces; following up Maxwell's remark that gold leaf is far more transparent for the rapid electric alternations in light than its steady electric resistance would lead one to expect. It is curious that Maxwell himself has nowhere indicated the application of his theory to the dynamically fundamental subject of reflection. In a letter of 1864 to Stokes [2] in which he hints at his electric theory, then taking form, he remarks: "I am trying to understand the conditions at a surface for reflection and refraction, but they may not be the same for the period of vibration of light and for experiments made at leisure."

Other early papers published in Dutch, and reported in the *Beiblätter* by long abstracts, include a discussion of the propagation of sound according to the kinetic theory of gases (1880), and a note (1882), stimulated by a discussion of Korteweg, on formulæ for the interaction between two electrodynamic elements constructed after the manner of that of Ampère.

The famous memoir in which he applied for the first time considerations relating to discrete molecules to electric propagation in material bodies, and incidentally arrived at a rational refraction-equivalent $(\mu^2-1)/(\mu^2+2)\rho$ for each substance, independent of its density, is abstracted by himself in *Annalen der Physik*, ix., 1880, pp. 641-684. Here again the version of Maxwell's theory developed in the first of Helmholtz's critical memoirs (1870) is followed, possibly as being more accessible outside England. Indeed the expression for the refraction-equivalent is largely independent of any particular theory of propagation in the molecular medium; as is illustrated by the fact that his formula was identical with a result deduced ten years earlier in Danish on lines of elastic solid theory by his namesake L. Lorenz. The discussion of its range verified the rough substantial invariance of this expression even for change from the gaseous to the liquid state, and showed that it provides an additional atomic constant persisting through many types of chemical bonding of the atoms. This is now of course a large domain in physical chemistry.

The contribution of a vibrating molecule to the radiation is treated, after the manner of the general Stokes-Kirchhoff equations, in close correspondence as it happens with the familiar later formulation of Hertz for a dipole vibrator emitting electric radiation. Extension to include optical dispersion is considered. The result, already known to the masters, is enforced that Cauchy's statical theory which ascribed dispersion to a sensible value of the ratio of molecular distance to wave-length, is for actual matter entirely insufficient, unless as he remarks the laws of attraction are quite changed at molecular distances: but its effect is not absolutely null, and it is pointed out that cubic crystals, which are isotropic on Maxwell's theory, should on this account exhibit a small secondary double refraction of very symmetric type. Recently Prof. Lorentz has returned to this topic, and announced the detection of this quality, amidst others due perhaps to imperfection of the crystal, in his laboratory at the Teyler Institute. The detailed investigations of Rayleigh (1892) on atomic obstacles arranged in lattices stop short of the approximation here required. Later both Lorentz and Rayleigh noted that a perfect crystal should not scatter at all the light passing through it.

A static theory being thus inadequate, dispersion has to be ascribed to resonant vibration excited in the molecular structures. He works out as an example the very simplest ideal case, that of an electric charge e attracted to a massive nucleus by elastic force proportional to distance; which is the identical illustration that served him nearly twenty years later to elucidate the Zeeman magnetic spectral effect and the polarisation of the emitted radiation. The result of course also provides an illustration of the anomalous or selective refraction discovered by Kundt, which he does not then notice, restrained possibly by our ignorance which he remarks of the actual structure of molecules. Nowadays the argument for the Lorentz refraction-equivalent is made almost intuitive by correlating it with the equivalent $(K-1)/(K+2)\rho$ for the dielectric inductance K, usually ascribed to Mosotti and to Clausius. No demonstration could however be simpler than the one given even earlier by Maxwell in 1873 for the cognate problem of the conductance of a medium filled with small spheres of different material: "Elec. and Mag." i., § 314.

In 1884 Prof. Lorentz directed his attention to the

[2] "Scientific Correspondence of Sir George Stokes," vol. ii. p. 26

effect which magnetisation exerts on the polarisation of reflected light, discovered by Kerr in 1878, and discussed immediately after on the basis of general theory by FitzGerald but only for transparent media. A magneto-optic constant had to be introduced for each metal, naturally of complex type, which might be regarded as continuous with the constant of the Hall effect for a steady field. Experimental research, based on his formulæ, was started in the laboratory of Prof. Kamerlingh Onnes by Sissingh in 1886, in collaboration from 1889 with Zeeman: and their results are finally reported in *Archives néerlandaises*, 1894. Everything connected with magneto-optics excited great interest in England from the time of Faraday's fundamental discovery, and the stimulating dynamical speculations of Kelvin (and Maxwell, "Elec. and Mag." ii.) connecting it with a rotatory molecular theory of magnetism. The discovery of Kerr intensified the interest. The very exact material provided by Sissingh and by Zeeman was available as a test for a concentrated theoretical formulation. One may be permitted to claim that the most systematic theoretical development and thorough verification of the subject, remarkably consistent on all sides, is in a Cambridge Fellowship dissertation by J. G. Leathem, Phil. Trans., 1897, pp. 89-127, which has scarcely received the attention that it deserves. This theory attains even to features of exact prediction, which had been anticipated in a dissertation in Dutch by C. H. Wind shortly before.

About 1897 came the cardinal discovery of the effect of a magnetic field on spectra, by Zeeman, which was worked out in the early stages in the light of Lorentz's theoretical guidance. As already remarked, the elementary illustration by a single vibrating ion under elastic control, which covers all the normal features of the Zeeman subdivision, had been used to illustrate optical dispersion long before. The results admit of easy extension to any system of electrons describing interacting free orbits, however complex, about a massive positive nucleus. When there are more than three components in a spectral line, the vibrating system must be more complex. The application of the theory of the small vibrations of general dynamical systems, which suggests itself at once, gave no help and it was scarcely to be expected that it would. Recent schematic solutions employing the language of quasi-periodic systems are said to cover thoroughly the whole ground: it would be most interesting to have Prof. Lorentz's reasoned views on the promise held out by this rather inscrutable type of analysis. One observes that he uses here as elsewhere the well-tried method of discussion by mirror images, to fix the types of symmetry (cf. *Astrophys. J.* 1899): the magnetic field is reversed in the image in order to avoid change of signs of all the charges, which would lead to negative nuclei and positive electrons.

There is a paper of 1892 in *Ann. der Physik* on refraction across thin metal prisms, in which one discovers a discussion of an essential point often sought for, namely, the influence on the direction of propagation by rays of the steep gradient of amplitude along the phase-front of the emergent train. The introduction to this paper is on lines now strangely familiar; an investigation of what type of differential equations one is formally restricted to by the principle of invariance alone, in order to give rise to simple trains of damped undulations in an isotropic absorbing medium.

We come now to the two famous memoirs "La Théorie électromagnétique de Maxwell et son application aux corps mouvants," *Archives néerlandaises* 1892 (pp. 189) and "Versuch einer Theorie der elektrischen und optischen Erscheinungen in bewegten Körpern," 1895 (pp. 139), both published as separate treatises. Both of them proved to be very difficult, in comparison with previous memoirs on cognate matters, partly on account of the strangeness and complexity of the notation and analytical processes to English readers saturated with Maxwell's notation and his more intuitive procedure. One might perhaps guess that both of them were worked up gradually, as seems to have been Prof. Lorentz's custom, out of professorial lectures: for they include digests of previous papers. The main feature in both is the expansion of the Maxwell theory on the basis of mobile elementary ions, regarded simply as coherent volume distributions of electricity, as the sources of the field. That point of view had already been clearly expressed in the paper of 1878-80 on refraction-equivalents and incidentally on the explanation of dispersion, but was then developed more in terms of attractions at a distance after Helmholtz. As regards the dynamical side, both memoirs proceed through the principle of d'Alembert in a form which makes it to some extent a substitute for minimal Action. Looking through them in the light of to-day the second, which appeared early in 1895 and referred largely to optical phenomena, seems much the more striking. Thus he recognises that the Maxwell stress for free space does not balance when the state of the system is not steady, unless a quantity which Poincaré afterwards described as a distribution of a momentum connected with the stress is taken into account: this was the beginning of the stress-energy-momentum tensor. The correction in the Fresnel convection-coefficient for transparent media is obtained, arising from dispersion, which in recent years Zeeman has fully verified. All kinds of optical convective phenomena are closely considered.

But the main result is the establishment of a systematic correspondence between the electrodynamic fields of a material system at rest in the aether and the same system convected with a uniform velocity v. The result in its simple form holds only up to the first order of v/c. The fields are not identical, unless certain of the vectors are ignored as being unreal and merely mathematical expressions. But he points out that all relations concerned with the interactions of matter, such as alone experiment could test, are unchanged by the convection. This is the first systematic appearance of the electrodynamic principle of relativity. It can be extended in modified form with confidence to the second order of v/c, at any rate on an electric theory of matter, for the electrons within the atom are still small enough compared to their distances apart to be treated as point charges; and that covers the whole practical field except the domain of β rays. But when, as Prof. Lorentz noted in 1904, the truth of the result as thus extended is found to hold for the field up to all orders, the completion of this exact correspondence to include the atomic structure has to become a postulate or assumption: that was the birth of the modern efforts towards unrestricted convective relativity as an abstract formulation holding far beyond experimental verification.

There is a striking formal analysis near the end for the effect of convection on rotational optical media. For an isotropic medium the ordinary rotational modulus will be altered, and also a new rotational effect involving interaction of the vector velocity of convection with the vectors of the field can arise. As the result is of the first order in v/c, it is difficult to see how it could exist on a purely electric theory of atomic structure; so that the two formal effects should cancel. It appears that the experiments of Mascart (1872) were scarcely adequate to verify this absence of effect. Anyhow the principle of electrodynamic relativity repudiates any effect altogether.

Hitherto the transformation, up to the second order, for convection was ascribed to the molecular system, the frame of reference of space and time remaining invariable. For steady states of the system, in which time does not come into consideration, it meant a shrinkage along the direction of convection: changes so rapid that the alteration of the measure of time could be effective scarcely occurred, and were put aside. When Prof. Lorentz pointed out that the transformation, which is now known by his name, was exact as regards electrodynamic fields in free space, and also exact to some extent when there are electric densities in the field, the subject took on a new and wider trend. The transformation was transferred by Einstein (in recent years attached to Leyden as part-time Professor) to the frame of space and time instead of the molecular aggregations of matter, each taken separately, which accidentally occupied it. The question is then no longer confined to shrinkage of the material frames of terrestrial experiments: effects must be expected over astronomical distances across empty space. Adaptation of the Newtonian law of gravitation into a form invariant for the fourfold space-time frame of Minkowski, which was the final analytical consolidation of this aspect of the subject, was effected by Lorentz and by others with a view to search for astronomical indications, and in particular to find out whether the outstanding minute secular rotation of the orbit of the planet Mercury, already the standard test for modified laws of gravitation, became amenable. The changes thereby introduced proved to be of small account.

Meantime Einstein seems to have been struggling to get rid of the Minkowskian uniform universal space-time, which was just as absolute in its combined four dimensions as was the Newtonian scheme of separate space and time. By identifying locally the essential features of a physical field with intrinsic differential constructs in the fourfold expanse, named tensors, of which a formal calculus had already been fully developed by Ricci and Levi-Civita, he was able finally to select a group of related local tensors as the result of tentative adaptations so as to exhibit the now famous view of gravitation as represented by warping of the fourfold pseudo-spatial expanse around the material nuclei. Though this can scarcely be said to have explained gravitation, it has been widely held to have explained (or abolished) space and time: it merely forced gravitation, just as it happens to exist, into the electrodynamic frame with its property of insensibility to uniform convection, with no detriment to the results of Newtonian physical astronomy and a rather better account of the problem of the Mercury perihelion.

This empirical building up of a field of gravitation out of tensorial constructs belonging to a space-time expanse, now differentially heterogeneous, was completed by adapting the Minkowskian vector potential of the pervading electrodynamic and optical field to the same conditions. The need for a more physical setting, at any rate to those who believe in minimal Action as the ultimate and necessary binding principle in physical analysis of a molecular world, seems to have been met immediately to a considerable extent by Lorentz and soon after by Einstein himself and by Hilbert. "The discussion of some parts of Einstein's theory of gravitation may perhaps gain in simplicity and clearness, if we base it on a principle similar to that of Hamilton. . . . Now that we are in possession of Einstein's theory we can easily find how this variation principle must be formulated for systems of different nature and also for the gravitation field itself" (Proc. Amsterdam Acad., Jan. 30, 1915). This is not the place to pursue the contentious view (cf. *Phil. Mag.*, Jan. 1923) that the Least-Action dress, just because it is so closely interwoven, is like the shirt of Nessus, and tends to make havoc of the spatial philosophy though without destroying the tentative validity of the elegant analytical method. Possibly Prof. Lorentz may be tempted to unravel this question in his admirable judicial manner.

In the subsequent years the Proceedings of the Amsterdam Academy became a focus for the literature of the gravitation theory, mainly in a series of papers, apparently first delivered as lectures, by Prof. Lorentz himself, in which he develops the tensor scheme in an elegant way of his own by a differential geometry involving use of infinitesimal loci of constant geodesic radius as a kind of indicatrix. Among many other papers, doubtless arising from a common inspiration, one recalls Droste's determination, simultaneous with Schwarzschild's solution, of the exact gravitational field of a particle, and Nordström's of the field of an electron.

One can look back, still with undiminished surprise, at the vast mass of intricate literature on this subject which flowed westward, mainly from Berlin and Leyden and Göttingen (and also from Italy), when Central Europe was again thrown open after the end of 1918. The difficulties of a strange though potent and elegant calculus could be surmounted by application: but the mysteries of unfamiliar meanings and implications in imaginary space and time could give rise to abundant misconceptions. The uninitiated must still be wary in approaching this unexplored and treacherous domain, in which Prof. Eddington has recently detected for us, by beautiful analysis of algebraic tensors, how mere co-ordinates are liable to undulate across the field on their own account entangled with the gravitational waves in the underlying spatial reality.

There is no space to pursue this review of Prof. Lorentz's work further. A survey of his activity is a liberal education in the history of physical science for the last half-century. Reference to the Proceedings of the Amsterdam Academy for the last twenty years, in the handsome form of the edition in English, will reveal the breadth and informative character of his investigations. But this series of volumes is long and portly; and he would confer a great boon on students of physical science the world over if he could manage to continue the edition of Collected Papers of which the first volume appeared in 1907. He will be excused the task of reconstruction to bring them up-to-date which he then essayed, and which perhaps has been a cause of the delay.

Needless to say, Prof. Lorentz has attained to all the distinctions all over the world that are appropriate for a man of science. He has long been a Foreign Member of the Royal Society, and is in the lists of Rumford and Copley medallists. For the working congresses on the theories of physical science that are a feature of our time, he is an almost indispensable chairman. Great linguistic gifts, abounding learning, clear and rapid grasp of a point of view and prompt exposition of it in a different language, ease of approach, tolerant appreciation and encouragement of speculations still unverified, are familiar to his scientific colleagues. We may hope that his time will not be diverted overmuch to administrative work such as could be done by others. JOSEPH LARMOR.

The Botanical Survey of British Malaya.

The Flora of the Malay Peninsula. By H. N. Ridley. Vol. 1: *Polypetalæ.* Pp. xxxv+918. (London: L. Reeve and Co., Ltd., 1922.) 63s. net.

THE Malay Peninsula, for which the opening volume of a Flora by Mr. H. N. Ridley has been published "under the authority of the Government of the Straits Settlements," is an important and, save for the narrow northern section nearest Siam, a typical province of the Tropical Rain-Forest Region. Though Europeans secured a footing in this Peninsula four centuries ago, the survey of its vegetation was long deferred. The Portuguese, who occupied Malacca in 1511, had done little before their expulsion by the Dutch in 1641. The Dutch, who, with two short breaks (1795–1801 and 1807–18), owned Malacca till 1825, scarcely did more. Rumpf, whose "Herbarium Amboinense" (1750), completed on September 20, 1690, surveys the vegetation of the Malay Archipelago, avoided dealing with Malacca. Rumpf regarded the Malay Peninsula as belonging to continental India, and Valentijn, in his "Oost-Indien" (1726), held the same view.

The British became interested in the Peninsula when Penang was acquired in 1786. Sir Joseph Banks, president of the Royal Society, satisfied the directors of the East India Company that a survey of the vegetable resources of their territories was essential, and in 1793 the Calcutta Botanic Garden was permitted to add survey operations to its acclimatisation work. The investigation of the vegetation of the Peninsula, then begun in Penang, was extended to Malacca when that Settlement was first captured from the Dutch in 1795, and to Singapore when that Settlement was founded at the second restoration of Malacca to Holland in 1818. Before Malacca became permanently British in 1825, Banks had died and the company had adopted another policy. Botanical survey at Calcutta was inhibited, and during 1828–32 the company dispersed the contents of the Calcutta Herbarium.

The valuable work accomplished by the Calcutta Garden since 1793 in Penang and Singapore, however, could not be undone; as regards Malacca, the reproach to England induced by this retrograde policy was removed by the private exertions of Griffith during 1841–44 and Maingay during 1862–69, whose collections went to Kew. Largely owing to Griffith's work, more than one-sixth of the plants described by Hooker and Thomson in their "Flora Indica" (1855) are Straits Settlements species; thanks to Maingay, the Straits Settlements plants in the two opening volumes of Hooker's "Flora of British India" (1872–79) rose to nearly one-fourth of the whole. During 1874–79, the Straits Government organised relationships with the western Native States which rendered the latter accessible. To assist Hooker the Calcutta Garden undertook, during 1881–86, the botanical investigation of Pêrak, and the Malay Peninsula plants described in those parts of Hooker's Flora issued during 1887–97 rose to nearly one-third of the whole.

In 1888 Mr. Ridley was appointed Director of Gardens and Forests, Straits Settlements; in 1889 King, at the desire of Kew and of the Straits Government, began at Calcutta his "Materials for a Flora of the Malayan Peninsula," as a supplement to the Indian Flora Hooker had already issued and a precursor of the Malay Flora Mr. Ridley has now commenced. By 1902 King had completed the Polypetalæ; the Materials of 1889–1902 thus correspond with the 1872–79 parts of Hooker's Indian work and with the first (1922) volume of Ridley's Malay flora. Two-fifths of the plants in King's Materials had not been reported from the Peninsula when Hooker's work was written; one-third were new species. Nearly one-fourth of the plants now described by Mr. Ridley had not been reported from the Peninsula when King wrote; one-seventh are species discovered since the Materials appeared. The vegetation of the Peninsula in wealth and variety claims comparison with the richest province of the Tropical Rain-Forest Region.

If much has been done to remove what was long a reproach to Europe, much, as Mr. Ridley explains in his introduction, has still to be accomplished before the vegetation of the Malay Peninsula can be regarded as fully investigated. A generation hence the additions to his Flora may be as extensive as his additions to King's Materials. This only increases our obligation to him for placing at the disposal of economic students the ripe and exact knowledge of which he has such a store, and gives rise to the hope that he may soon complete the task so worthily begun. His descriptions are clear and concise, and he has done well to confine his citations of earlier authorities within rigid limits; if there be a fault, it lies in the fact that occasionally he has exceeded his own limits by omitting references to the works he usually cites. By adding text-figures illustrating most of the families discussed, he has enhanced the value of the work; Mr. Hutchinson's drawings are so effective that the only regret they cause is that they should be so few. Those who use the work will not confine their commendation to the author and his artist; if the price be considerable, it will at least be conceded that printer and publisher alike have fulfilled their duties well.

Geodetic Levelling.

Ordnance Survey: The Second Geodetic Levelling of England and Wales, 1912–1921. Published, by Order of the Ministry of Agriculture and Fisheries, by Col. Sir Charles Close, Director-General of the Ordnance Survey, Southampton, 1921. Pp. 62+46 plates. (London: H.M. Stationery Office, 1922.) 17*s*. 6*d*. net.

THE accuracy of modern levelling is a thing which always causes surprise when the great number of separate operations which enter into the composition of a line of any length is considered.

In the work under notice perhaps the most striking result is that the line of levelling starting from mean sea level at Newlyn, not far from Land's End, and terminating at Dunbar on the coast of Haddingtonshire, generates in all that distance of about 600 miles a probable error of only two inches, so that, when it was found that mean sea level at Dunbar was ten inches above that at Newlyn, it was possible to say with confidence that the discrepancy was real and due to a deformation of the mean sea-level surface and could not be attributed to an accumulation of error in the levelling.

The volume contains an introduction by Colonel Sir Charles Close, four chapters by Lt.-Col. A. J. Wolff, and five by Mr. H. L. P. Jolly. The operations which it describes fall into two separate parts, namely, the determination of the mean sea level and the levelling.

Though the old levelling of England had mean sea level at Liverpool as its datum, the height of mean sea level had not been determined with accuracy, and a new determination was necessary; it was very desirable also to obtain records whereby the fluctuations of mean sea level could be examined and analysed. Accordingly, three tidal observatories with automatic gauges were established, at Newlyn, Felixstowe, and Dunbar respectively. In the selection of these places the late Sir George Darwin was consulted.

The levelling shows that the equipotential surface through the mean level of the sea at Newlyn passes well below mean sea level at Dunbar and slightly above that at Felixstowe. There is thus a question as to what should be adopted as the datum for the levelling. Either the mean of the different sea levels might have been used or the equipotential through mean sea level at one point might be the datum for all. The latter was decided on and the decision was unquestionably right.

An interesting chapter is devoted to the effect of meteorological conditions on the level of the sea. This shows that part of the discrepancy of 0·81 ft. between mean sea level at Newlyn and Dunbar can safely be attributed to the fact that, for the six years during which the observations continued, the average barometric pressure was higher at Newlyn than at Dunbar by 0·108 in.; this would depress the level of the sea at Newlyn by about 0·12 ft. The greater portion of the difference still remains to be accounted for, however, and it seems that the cause may best be sought in the effect of wind.

The relation between the daily mean level of the sea at Newlyn and the atmospheric pressure-gradient has been studied and a formula deduced that gives results in wonderfully good accordance with observation.

That the levelling was carried out with conspicuous care and success is demonstrated by the smallness of the probable error of the long line from Newlyn to Dunbar; and the heights of the bench-marks are now known with such accuracy that if in the future these are found to have changed it will undoubtedly indicate that the marks have moved. The old levelling of 1850 was unfortunately not precise enough to permit of the differences found, considerable though they were, being attributed to real movement.

Particular attention has been paid to the design and to the selection of the situations of the bench-marks, on the stability of which the value of the work depends. The sites have been chosen with special regard to the geological conditions, "avoiding as far as possible the softer rocks and those liable to surface changes."

In the design of the primary bench-marks an interesting detail is that two reference marks, situated side by side, are provided in each; one is a piece of gun-metal and the other a polished flint. The number of primary bench-marks is large, the interval between them being on the average about thirty-five miles, and it is scarcely possible that any upheaval or subsidence of a geodetic kind can take place without affecting the heights of some of them.

The discussion in Chapter IV. of the dynamic and orthometric connexions is clear and good, but it should perhaps have been stated, with reference to the formula for the value of gravity, that though in all probability the results obtained by the use of Helmert's constants are sufficiently accurate, yet the correct quantity to employ is not the computed value of gravity but the actual value obtained by observation. We may feel tolerably sure, from experience gained in other countries, that the difference between these two values will not be great, but as no gravity survey of this country has ever been made we cannot say that we *know* that that is the case.

The errors to which levelling is liable are fully discussed in Chapter VIII. The origin of the systematic errors, which are undoubtedly met with, is obscure. It is here stated that "the systematic error must be systematic with respect to something and there is always the possibility of finding out what the determining condition or thing is. It is a matter of almost universal experience that the direction of levelling is one such condition." Until, however, some satisfactory explanation has been given of the way in which the direction affects the errors it cannot be said that the connexion has been definitely established.

The French levellers, under the direction of M. Ch. Lallemand, have probably paid more attention to this question than any one else, and it is worth noticing that the early procedure was to do the levelling in both directions on the same day, whereas now the rule is to do the second levelling on a different day. If the systematic error were principally due to the direction the best procedure would clearly be to do the two levellings on the same day, under as similar conditions as possible, when the effects of direction on the two results could be expected to be equal but opposite. It seems that this was the original expectation; experience, however, showed that the expectation was not fulfilled, and so the preference was given to separate dates, "qui assure" (to quote M. Lallemand) "une plus grande variété dans les conditions atmosphériques d'exécution des deux nivellements et, par suite, en cas de concordance de ceux-ci, autorise davantage à penser qu'ils sont exempts d'erreurs systématiques."

This evidence, however, is not very conclusive. Concordance may merely indicate that the errors were equal and of the same sign in both cases, so that whatever error there was will appear undiminished in the mean. Discordance means that most probably the errors were of opposite sign, but, the conditions under which the two levellings were done having been different, it would be unjustifiable to assume that the errors were equal. In neither case, therefore, have we any certainty that the mean of the two results will be free from error.

We agree with the statement made in Chapter VIII. "that there is reason to doubt whether the systematic error in the mean levelling of a line, derived from the discrepancy between the backward and forward levelling, is a reliable guide to the actual accumulation of error within the line."

Putting aside such matters as instability of pickets, which are clearly capable of producing a systematic effect depending on the direction in which the work proceeds, the connexion between the remainder of the systematic error and the direction does not seem to be well established and is a matter which calls for further investigation.

Turning to the equipment which was used for the levelling, special attention is due to the staves called the "Cambridge Staves," which came into general use in 1914. They are described by Lt.-Col. Wolff in Chapter II. The novelty of their construction is that the graduations are not on the wood of which the body of the staff is composed, but on a strip of invar let into a groove on the face of the staff. This strip is firmly attached to the base of the staff, and is presumably kept taut by some arrangement fixed at the top, but this detail of the construction is not given.

The thermal expansion of invar is so small that no account has to be taken of changes of temperature, which simplifies the computations and adds to the precision of the work. Staves of this pattern would be still more advantageous in countries where the climate is less temperate than it is in England.

The book is well illustrated, and the closing errors, discrepancies, adjustments, and route-profiles of the circuits are very clearly displayed in a series of diagrams. The work is well produced on the whole, but there are signs that the printers were not quite accustomed to mathematical symbols with accents, subscripts, etc. These are minor blemishes, however, and do not detract from the great value of this admirable piece of work.

G. P. L. C.

Scientific Work in the Dutch East Indian Seas.

De Zeeën van Nederlandsch Oost-Indië. Uitgegeven door het Koninklijk Nederlandsch Aardrijkskundig Genootschap. Pp. ix + 507. (Leyden: E. J. Brill, 1922.) 20 guilders net.

THIS heavy volume, illustrated with numerous photographs and several folding maps, treating of our knowledge of the Dutch East Indian seas, is published by the "Koninklijk Nederlandsch Aardrijkskundig Genootschap" on the occasion of its fiftieth anniversary. In it, six specialists give a summary of the work done in their respective branches of science, and the results are worthy of the attention of many more than those acquainted with the Dutch language.

In the first chapter, Col. l'Honoré Naber gives a historical sketch of the research work that has been done, beginning with the famous Marco Polo, the first European who travelled in those seas in the thirteenth century, and whose book was translated into English by H. Yule (London, Cordier, 1903). More important for us, however, are the expeditions of the last century, when the *Challenger* began the work which was carried on by the *Siboga* and the *Bali*.

The second chapter, bringing forward Adm. Tydeman's work on the depths of the sea, is accompanied by a splendid map, showing the extension of the flats, as well as the distribution of the curious deep channels or troughs, that form one of the most characteristic features of this part of the world; for example, the Java trough, 6000-7000 metres deep, the Mentawei trough, and the well-known Mindanao trough, where the greatest depth of the sea, between nine and ten thousand metres, is found.

Then follow accounts of investigations on temperature, salinity, density, and dissolved gases in the sea water, communicated by Prof. Ringer. Many diagrams and tables are a welcome guide in what might have been a labyrinth of ciphers.

An account of the maritime meteorology and the tides, written by Dr. van der Stok, and illustrated by maps and tables, explains the interesting phenomena which tide-waves show in an archipelago, the isles of which form numerous obstacles to the movements of the water. The theoretical part of this chapter is highly interesting.

Dr. Max Weber's treatise on the biology of the sea is very important, as might be expected from the leader of the *Siboga* expedition. The different zones of life in the oceans, the coral reefs, and the conditions of deep-sea life are especially treated, and Mrs. Weber-Bosse adds an important chapter on plant life in tropical seas, which is so absolutely different from our coastal vegetation, where only very few Phanerogamæ come down to and into the salt or even brackish water of bays and estuaries.

The next chapter, on the geology of the region, by Prof. Molengraaff, is perhaps the most interesting of the volume. The writer first points out the remarkable difference between the western and eastern parts of the Archipelago. The western part, the shallow Soenda sea, was dry land during the Glacial period, while in the eastern part rows of little islands alternate with deep-sea basins, causing a very unequal relief of the sea bottom. The theory of the sinking of the sea-level and the coral-reef problem, which are narrowly interlaced, are amply discussed. Good maps help to make these difficult problems easier to understand.

In the last chapter Adm. Phaff gives a description of the coast lines of the East Indian Isles.

In his preface Dr. W. v. d. Stok states that only new and very costly expeditions will be able to bring new light on the subjects treated in this volume, so we must therefore be glad to possess such an excellent summary of our knowledge of the East Indian Seas.

W. G. N. VAN DER SLEEN.

For the Diffusion of Knowledge.

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures, and Condition of the Institution for the Year ending June 30, 1920. (Washington: Government Printing Office, 1922.)

OF the 704 pages that make up the volume before us, 550, accompanied by 230 plates, are assigned to the appendix. The body of the report is somewhat dead by now, but the large tail is still lively enough to attract attention. It consists, as usual, of papers general in character and ranging over the field of human intellect from astronomy to fine art. There are 27 such papers, of which 14 are original and by Americans, and 13 are reprints or translations of articles by American, British, and French authors. All are examples of popularisation of a high type, and many of them could be understood by readers with little or no previous knowledge of the subject. The names of H. H. Turner, W. D. Halliburton, M. Caullery, and Auguste Lameere among the foreign authors indicate the general excellence. The papers that appear here for the first time are, to a large extent, summaries of work that has been published elsewhere, but some of them contain matter that seems to be fresh.

Dr. N. E. McIndoo's article on the senses of insects may serve for example. After discussing the nature of insect vision by the simple and the compound eyes, he proceeds to the sense of smell, and considers it first as a means of recognition. In insects that sense is far more developed than in man, yet Dr. McIndoo found that by smell alone he could distinguish the three castes of bees as well as other components of the hive. It is probable that each individual bee has its peculiar odour, but the combination of all these that makes up the hive odour is regarded as the most important, as indeed the ruling power in a colony. It "is a means of preserving the social life of the bees from without, and the queen odour which is a part of it insures continuation of the social life within. The workers 'know' their hive-mates by the odour they carry. This insures harmony and a united defence against attack. The queen odour constantly informs the workers that their queen is present. Even though she does not rule, her presence means everything to the bees in perpetuating the colony. Thus, by obeying the stimuli of the hive odour and queen odour, and being guided by instinct, a colony of bees perhaps could not want a better ruler." Among ants the same broad principles hold, but here the family odour retains its importance.

What then are the organs by which insects recognise these odours? Dr. McIndoo has identified them as small pores scattered or grouped on the body and appendages. A nerve ends in each pore, and the opening is often protected by a hair. By covering the pores, experimental proof of their olfactory function was obtained.

That bees, among other insects, can discriminate between foods is well known, and that their power of discrimination exceeds that of man was experimentally proved by Dr. McIndoo. He ascribes this power, however, not to taste, but to smell. Taste and smell are closely allied, and it is possible that the only difference lies in the organs that respond. the stimulus itself being identical. In bees there appear to be no such organs connected with the alimentary tract, so that the discrimination is probably by smell.

Passing over the sense of touch, we find some novel remarks on the sense of hearing, and an interpretation of certain organs on the antennæ (pore-plates and Johnston's organ) as possibly auditory in function, though the audition can, in that event, be little more than an exaggerated sense of touch.

Whether there are in insects or in any other animals senses of a nature entirely hidden from us, is a question raised by Mr. H. H. Beck in an article on "The Occult Senses in Birds" (reprinted from the *Auk*). In some species of moth, for instance, a female exposed but invisible will soon attract the males of the species. Various explanations of this have been suggested—from Mr. Beck's "mate-finding sense" to wireless telegraphy, but Dr. McIndoo believes that the highly developed sense of smell is enough to account for it. The same faculty surely renders it unnecessary to postulate, with Mr. Beck, a special "food-finding sense," though his story of vultures from eight miles away spotting a freshly-killed dog at the bottom of a sink-hole is certainly uncanny. Then there is the homing sense—the most puzzling of all; but it seems less rational to demand some mysterious force, as Bethe does, than to suppose the exercise of the usual senses more highly developed than a townsman can ever imagine, used simply or in combination, consciously or unconsciously.

One might pass on to consider some curious instincts set forth in the account of two insects of the orchard, by Mr. R. E. Snodgrass, or to learn a lesson from Prof. Lameere's lecture on the origin of insect societies. Or one might get practical hints on the suppression of insect pests by a better utilisation of birds from Mr. W. L. McAtee, or excite oneself over the adventures in the life of a fiddler crab, so delightfully told by Mr. O. W. Hyman. But we must reluctantly pass all these, and pass too Mr. Bassler on the little Polyzoa, Mr. Gilmore on the mighty horned dinosaurs, Mr. Maxon on the Botanical Gardens of Jamaica, Mr. Safford's strange study of the narcotic Daturas, and the richly illustrated articles on Hopi Indians, modern Mexicans, and racial groups and figures, by Fewkes, Genin, and Hough. We must end, but we permit ourselves the perhaps too obvious comment, that this publication is indeed an admirable example of "the diffusion of knowledge among men."

Our Bookshelf.

Introduction à la géométrie non-Euclidienne. Par Dr. A. MacLeod. Pp. 433. (Paris: J. Hermann, 1922.) 20 francs.

In the theory of relativity, on which so much has been written during the last few years, one of the main difficulties encountered by most readers is the unfamiliar conception of space and time involved. Apart from the difficulty in the conception of a space-time continuum, the notions that space as we know it may possibly be only of limited extent, and that the sum of the angles of a triangle is not necessarily equal to two right angles, are apt to prove only too bewildering to readers whose knowledge of geometrical matters is confined to the Euclidean system.

The question whether the axioms imposed by Euclid are necessary for building up a logical system of geometry has long engaged the attention of mathematicians. In the non-Euclidean system, largely developed by Gauss, the absolute, *i.e.* the "circular points at infinity" of Euclidean geometry, is replaced by a non-degenerate conic. All this entails revised definitions of such terms as "distance" and "right angle."

Dr. MacLeod in the work before us presents the subject with strict logical precision, the reasoning which leads to the various results being given fully and accurately. The actual amount of ground covered is not so great as in Mr. Coolidge's treatise, a book which occasionally suffers from over-condensation. Uninitiated readers will be interested in noticing that the proof of a familiar proposition, that the greater angle of a triangle is opposite the greater side, requires six pages of reasoning. The book would have been improved by more diagrams, but these can be supplied without difficulty. It can be recommended as an excellent introduction to the subject.

W. E. H. B.

History of the Theory of Numbers. By Prof. L. E. Dickson. Volume II. (Publication No. 256, Vol. II.). Pp. xxvi + 803. (Washington: Carnegie Institution of Washington, 1920.) 7.50 dollars.

The arithmetical questions treated by Diophantus of Alexandria, who flourished about the year 250 A.D., included such problems as the solution of the equations

$$x+y+z=6, \quad xy+z=u^2, \quad xy-z=v^2$$

in rational numbers. Little attention was given to this type of problem from Diophantus's time till that of Fermat (1650), the founder of modern Diophantine analysis. The most general arithmetical question to which the peculiar methods of Diophantine analysis apply is the determination of all the solutions in rational numbers of a system of algebraic equations.

$$R_i(x_1, x_2, \ldots x_n)=0, \quad i=1, 2, \ldots m,$$

there being more unknowns than equations. Particular problems of this type have attracted the attention of a very large number of workers.

Prof. Dickson, in the second volume of his History, gives an account of what has been accomplished in this field of thought. Original memoirs have been carefully scrutinised and abstracted. Naturally, in such a compilation, there is much matter which would not now be regarded as of any great scientific importance, and, in fact, the main value of many of the reports is on the side of historical development.

Scientifically, the most important chapters in the present volume are those on (i.) partitions of numbers, (ii.) representation of numbers as sums of squares, (iii.) Pellian equations, (iv.) indeterminate equations of the third degree, and (v.) Fermat's last theorem. It is to be trusted that the mathematical world will duly appreciate the immense amount of labour expended by Prof. Dickson in the preparation of such a book.

W. E. H. B.

Penrose's Annual: The Process Year Book. Review of the Graphic Arts. Edited by William Gamble. Vol. 25. Pp. xvi + 110 + plates + 64. (London: Percy Lund, Humphries and Co., Ltd., 1923.) 8*s*. net.

Mr. Gamble, in his editorial review of process work, looks back twenty-seven years to the first volume of this annual and remarks upon the improvement of the process block since then. He considers that it is now so perfect that there is little if any possibility of advance in this direction. "The signs of the times are that the process block has passed its prime and that there will be a slow and steady diminution of its employment." Rotary photogravure and off-set lithography are improving, and collotype is reviving, its most important application being in the highest grade of colour work.

The superseding of type composition by a photographic method occupies a prominent position in the volume. The "photoline process" of Mr. Arthur Dutton, though the machinery for it is not yet on the market, is so far perfected that we have here good examples of solid text, tabular matter, title pages, ornamental work, and a demonstration that any size of letter can be obtained from one master alphabet.

The body of the book contains several articles of exceptional value following the editor's general summary. Mr. Stanley Morison contributes a long and well illustrated historical article on "Printing in France," and "Printing in China" is dealt with in a shorter contribution by Mr. Gilbert McIntosh. There is also a note on the Garamond Type, with several examples of it. The illustrations representing process work are, as usual, numerous and very diverse. They include a reproduction from an impression of a wood engraving by the swelled gelatine method and a half-tone direct from Nature. Altogether it is a very interesting volume.

The Psychology of Thought and Feeling: A Conservative Interpretation of Results in Modern Psychology. By Dr. C. Platt. Pp. x+290. (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1921.) 7s. 6d. net.

THE author's claim in the sub-title is, on the whole, justified. The social and educational bearings of the subject are kept in the foreground; technicalities and controversial or metaphysical problems are, for the most part, avoided. On these terms, as stated in the preface, one is not led to expect more than one finds—a presentation that includes much of the newer teaching but does not break touch with older methods of treatment. The trouble, perhaps, is that if "metaphysical" problems be avoided the result is likely to be an emulsion in which the drops do not combine though they may be swallowed together. If we elect to follow M. Bergson and call the great life-urge the *élan vital*, the concept of nerve-force or neurokyme and that of unconscious cerebration can scarcely coalesce therewith; and if the nerve-force be said to leap a microscopic gap at the synapse, and if it be also said that at each of these gaps, a choice presents itself, the two statements do not seem to be "metaphysically" *in pari materia*. The author is doubtless not less aware than any of his readers of the difficulties that must arise if the more fundamental issues be passed over. For the most part he gives a reading of the facts which will be found sufficiently free from extravagance as to be spoken of as conservative.

Researches on Cellulose. By C. F. Cross and C. Dorée. IV. (1910–1921). (Vol. 4 of the Series "Cross and Bevan.") Pp. x+253. (London: Longmans, Green and Co., 1922.) 15s. net.

"CROSS AND BEVAN" are two names inseparably connected with our knowledge of cellulose. The present volume is a continuation of a series of monographs on the subject. Although the properties of cellulose are of such immense importance in nearly all branches of industry, the complexity of the subject is so great that, in spite of a considerable volume of valuable research, there are still many obscure regions. The authors have brought together the results of research carried out by various workers, with helpful and constructive criticism. The result is a very useful monograph, which will be of great value to workers in this field.

The Psychology of Day-Dreams. By Dr. J. Varendonck. With an Introduction by Prof. S. Freud. Pp. 367. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Company, 1921.) 18s. net.

THERE is much in Dr. Varendonck's book which will be of interest and of value to psychologists not only of the newer schools but also to those who are nowadays spoken of as "academic." The central aim is to disentangle under distinguishing analysis the part (1) played by "affective thinking" (or what Prof. Freud in the introduction prefers to call "freely wandering or phantastic thinking") in normal life, from (2) that which is played by psychical processes in which a higher order of reflective thinking takes some share. To this end, day-dreams are discussed with much patience and insight. The conclusion reached is that affective thinking may take place in the three levels of consciousness, but that unconscious and fore-conscious thinking are always affective. Where so much turns on the rôle of the affect, chapters on its relation to memory, apperception, ideation, and visualisation, and one on the issues of affective thinking, are helpful to an adequate grasp of the author's position.

The Common Molluscs of South India. By J. Hornell, Director of Fisheries, Madras. Report No. 6 of 1921, Madras Fisheries Bulletin, vol. xiv., 1922, pp. 97-215. (Madras: Government Press.) 1 rupee.

MR. HORNELL has arranged for the preparation of wall-cases containing collections of the common species of molluscs and crustacea for the use of secondary schools in India, and this useful handbook was written primarily as a descriptive guide to accompany the case of molluscs, but the needs of collectors who take an interest in the things they find on the shore have also been kept in mind. Mr. Hornell records the external features, the bionomics, the changes in form of the shell as growth proceeds, the character of the spawn, the use of molluscs as food, and the shells, opercula, pearls, etc., as articles of commerce.

The Evolution of Atoms and Isotopes. By W. D. Verschoyle. Pp. 40. (London: J. J. Keliher and Co., Ltd., Craven House, Kingsway, 1922.) 1s. 9d.

THE author of this pamphlet proposes, with the help of a bi-polar electron, to explain the evolution of atoms and to abolish positive electricity. He has been stimulated by the discovery of isotopes to develop further a series of numerical relations between atomic weights, some of which have already been described in the *Chemical News*.

An Introduction to Forecasting Weather. By P. R. Zealley. Pp. 32. (W. Heffer & Sons, Ltd., Cambridge; London: Simpkin, Marshall & Co., Ltd., 1922.) 1s. net.

THE pamphlet treats the subject of forecasting in an elementary manner, and may interest amateur meteorologists who have receiving sets for radio-telegraphy. The author is a technical assistant in the Meteorological Office stationed at Shoeburyness, and would be conversant with the official weather publications.

Ministry of Munitions and Department of Scientific and Industrial Research. Technical Records of Explosives Supply, 1915–1918. No. 9: *Heat Transmission.* Pp. iv+48. (London: H.M. Stationery Office, 1922.) 5s. net.

THIS report embodies in charts and formulæ the experiences of the Department of Explosives Supply on the transmission of heat to or from fluids flowing along pipes under various conditions, and will be found useful by engineers.

Letters to the Editor.

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

Broadcasting Transmitter.

I EXPECT that broadcasters would find that a definite generator of E.M.F. would give cleaner articulation than is probable with a transmitter depending on random variation of resistance. In other words that one of those telegraphic devices which I described long ago (Proc. Inst. E.E., vol. 27, p. 838, Dec. 1898), consisting of a light stiff coil of fine wire suspended elastically in an annular magnetic field, would reproduce speech and music better than a microphone. The fluctuations of the induced current in such an instrument are not capricious, and apart from stimulation it is silent; always provided that the exciting magnetic field is kept steady—a condition likely to be assisted by saturation of the iron magnet core, or by use of a sufficiently strong permanent magnet.

If an electromagnet is used, some contrivance is advisable whereby the coil circuit is automatically opened whenever the rousing current is put on or off. Otherwise, the response may be too violent for the valve and rest of the apparatus, not to mention a receiving ear. OLIVER LODGE.

Normanton House, Lake, Salisbury.

The Green Flash at Sunset.

SIR ARTHUR SCHUSTER in his review of Dr. Mulder's book on this subject states that "there seems no reason to doubt that dispersion combined with absorption of light completely accounts for the effect" (NATURE, September 16, p. 370). Yet Dr. Mulder's own view is that a complete explanation is still wanting.

My apology for again raising this question is that I believe I can supply from some recent observations what seems to be lacking in the dispersion theory, which fails to account for the remarkable variations in visibility of the green flash under apparently favourable conditions.

On the outward voyage to Australia to observe the solar eclipse of September last, I was struck with the faintness of the green flash at sunset, although the sky was clear down to the horizon. It was visible in binoculars (× 8), but scarcely, if at all, to unaided vision. On the return journey, on the other hand, the phenomenon was brilliant every evening on the run between the north-west coast of Australia and Java, and I was able to observe also what happened when Venus set in the sea. On this voyage the ordinary mirage effect was conspicuous, that is, distant land appeared raised above the sea horizon by a small interval, due to the total reflection of sky and land at the surface of a thin layer of air of low density in contact with the sea. At sunset the last segment of the disappearing limb was similarly reflected and reversed, causing a lenticular shape with the cusps raised about a minute of arc above the horizon. The green flash occurred when the green-edged cusps coalesced into a single bright patch, and this on one occasion turned to violet at the last moment.

The striking thing about the setting of Venus was the sudden appearance of a reflected image moving upwards to meet the descending image, and the instantaneous and conspicuous change of colour from dull red to green at the moment of meeting of the two images. The vertical spectrum of the planet caused by atmospheric dispersion was at no time visible in the binoculars, but the change of colour was probably due to the setting of the lower red of the spectrum.

It seems to me evident from these observations that the mirage layer greatly intensifies the ordinary dispersion effect, by adding the light from the reflected image to the direct image at the moment of setting. The normal dispersion effect at sunset under conditions when there is no mirage is scarcely visible to unaided vision, although easily seen in a telescope of low power. J. EVERSHED.

Kodaikanal Observatory, September 26.

Thermal Opalescence in Crystals and the Colour of Ice in Glaciers.

IN a previous communication to NATURE (vol. 109, page 42) it was pointed out that the thermal agitation of the atoms in crystals causes optical heterogeneity which should give rise to a noticeable scattering when a beam of light is sent through the substance, and that this effect may actually be observed with suitable arrangements in clear quartz or rock-salt. I have recently found that the same phenomenon is conspicuously exhibited by ice. If a block of clear ice, free from air-bubbles, striæ, or other obvious inclusions, and having flat sides, be held squarely and a narrow pencil of sunlight concentrated by a lens be passed through it, the track of the pencil shows a beautiful blue opalescence. It is advisable not to use a very highly-condensed cone of rays, as this would cause internal melting of the ice with formation of cavities which reflect white light and distract the eye. A dark background should be provided against which the track may be viewed. With small or irregular lumps of ice, the observation may easily be made by immersing the ice in clear distilled water contained in a glass flask which is painted black outside, windows being provided for ingress and egress of light and for observation of the opalescent track. Even with ice which at first looks unpromising owing to internal flaws or inclusions, portions in which the blue opalescence is not overpowered by disturbing effects may be picked out. A suitable orientation of the block with reference to the direction of the incident rays is often useful in avoiding reflections from cavities in the ice.

A comparison of the relative scattering powers of clear water and of ice at 0° C. is instructive. According to the measurements of Bridgeman, the compressibility of ice is 35×10^{-6} per atmosphere, and its refractive index is 1·310, while the corresponding figures for water are 52×10^{-6} per atm., and 1·334. The Einstein-Smoluchowski formula gives the scattering power of water at 0° C. as 144 times that of dust-free air, and if it could be applied in the case of solids, the scattering power of ice should be 79 times that of air. As has already been pointed out, however, the formula has to be modified in the case of crystalline solids, and a revised calculation indicates the scattering power of ice as about 30 times that of air, which is of the order actually observed in experiment.

The atomic scattering of light in block-ice demonstrated and measured in these experiments should certainly be capable of being observed on a large scale under suitable natural conditions. Indeed, it is well known that masses of ice in glaciers and icebergs often exhibit a blue colour, and it appears to the writer very significant that the circumstances in which natural ice shows a blue colour are precisely those found to be necessary in the laboratory in order that the blue opalescence due to internal scattering may be satisfactorily observed, that is, that the ice should be of the maximum clearness and transparency; in either case, air-bubbles, striæ, and other inclusions obscure the effect sought for. The inference that the phenomena arise in the same way seems legitimate.

I am aware that a different explanation of the colour of natural ice has been put forward by Tyndall and other writers, that is, that the colour is simply an absorption effect. To me, however, it appears that the latter view presents fundamental difficulties. *Prima facie*, no substance can exhibit colour *in its own body* except as the result of internal diffusion or scattering. Colour due to simple absorption can only be perceived when a luminous object is viewed through the substance, and even then it is the source, not the absorbing medium, that appears coloured.

The absorption theory thus leaves it unexplained why clear ice should exhibit any colour at all. Indeed, it would appear that the colour of ice is often very conspicuously observed when the light traversing it has no chance of reaching the observer's eye directly. Thus, for example, in his lecture on ice and glaciers, Helmholtz describes very vividly the experience of the Alpine traveller who, traversing the broken surface of the glacier along a narrow ridge, looks down into the crevasses on either side and views with mixed feelings of pleasure and awe their dark blue walls going down to the depths. It is obvious that in such a case as this, the light filtering *down* into the solid mass of transparent ice forming the glacier through the superficial layers or otherwise, has no possibility of returning to the observer above except as the result of internal scattering.

The natural view to take is therefore that the blue opalescence is the real cause of the colour of transparent ice observed under such conditions, the absorption of light in traversing the medium tending merely to diminish its intensity and make it of a more saturated hue.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta,
November 9.

The Cause of Chambering in Oysters and other Lamellibranchs.

THE phenomenon of chambering in oysters and other lamellibranchs is well known, and in oysters is a source of much financial loss to some oyster planters. In a chambered oyster one extensive closed chamber or several superposed large chambers may occur enclosed within the shell substance—usually in the convex valve, but sometimes in both valves. The chambers are separated from each other or from the body of the oyster by thin brittle partitions of shell only, and contain usually an evil-smelling liquid. When a chambered oyster is opened, great care is required lest the brittle wall of the chamber be broken and the evil-smelling liquid released on the oyster, which would in that case be rendered unfit for eating.

The cause of chambering has recently been described by Houlbert and Galaine (*Comptes rendus*, Acad. Sci. Paris 162, 1916), not as "un accident pathologique . . ." but "comme la persistence d'une propriété ancestrale." Later, these writers suggest inanition as a cause. In our recent investigation on oysters we have observed several phenomena which when pieced together offer a rational explanation of chambering as a minor pathological phenomenon due to varying external conditions coincident with variations in the internal condition of oysters.

We have observed that when oysters are kept in bell-jars or dishes in a warm room in the laboratory without food in winter they begin to grow shell automatically, whereas in the sea in a normal winter no growth of shell occurs; moreover, oysters kept in the laboratory in summer may continue to lay down shell at a rapid rate although food is practically absent. In such oysters it frequently happens that owing to the unfavourable conditions of transport in summer weather the oysters arrive in a bad condition, one of the effects of which—combined with the effect of the laboratory water—is to cause the oysters to shrink somewhat in their shell, but especially to contract the mantle, whereby puckers are formed in it. Now, although the mantle and body shrink, the layer of the mantle and body next to the shell continues to secrete shell substance in a thin layer. As a consequence of these conditions the oysters lay down on the inside of the shell a thin layer of shell-substance in an irregular manner, following especially the puckerings of the mantle. This thin layer of shell is laid down with a water space between it and the shell, and is, in fact, a small chamber. The same process occurs, as is well known, when mud gets into the shell accidentally, or when a hole is punctured in the shell and is afterwards plastered over with repair shell inside. The above facts show that shell is laid down automatically by the mantle and body surface adjacent to the shell if the temperature is sufficiently high and—it may be added—if the oyster is in reasonably good condition.

The second observation is well known to oyster-cultivators, namely, that oysters will swell considerably in water of low salinity and shrink in water of high salinity. This change occurs probably through the readiness of the bladder-tissue in lamellibranchs to respond and accommodate itself to changes in osmotic pressure. Now, chambered oysters occur most commonly on beds in high estuarine or riverine situations, where the salinity variations are great. The third factor of interest in this problem is that oysters vary greatly seasonally in weight, and, it can be safely deduced, in volume as well: very low salinities due to heavy rains would certainly also reduce the amount of available food-material for oysters. We have also observed that when oysters are kept for some months in tanks in stagnant water, the salinity of which thereby increases considerably, the percentage of chambered oysters is afterwards found to be very high and the bodies of the oysters shrink to a very great extent. The last factor of importance is this, that the rainy period in England falls either in the early part of the year or at the end of the year, while the month of May is fairly dry; but in May and June oysters prepare or begin to breed, and it becomes warm enough normally for shell to grow.

These observations may now be pieced together. In the early months of the year in high estuarine or riverine beds oysters are frequently subject to low salinities, *e.g.* 15 per cent. or even lower; towards May or June higher salinities will generally occur in these situations together with the onset of breeding among oysters; both these factors tend to reduce the volume of the body of the oyster, and—it has been noted—at a time when it is warm enough for shell-growth to take place. If the oyster is in good condition, shell-growth—it has been observed—occurs automatically. Thus, as the volume of the oyster is shrinking in these situations, shell material is being produced, consequently a shell lamina which is not adjacent to the existing body of the shell is laid down and a chamber results. Water probably forms in the chamber by percolation along the outside of the body of the oyster between the body and the shell. In this way are probably included in the chamber various organisms—present in the sea-water—which give rise to the unpleasant smell. The principal organisms concerned would appear to be the well-known anaerobic bacteria which produce hydrogen sulphide.

The cause of chambering among oysters on beds in high estuarine situations can therefore be stated to be the reduction in bulk of the body, which occurs at the shell-growing period in these situations from a variety of causes, of which the decrease of bulk due to breeding and salinity variations are the most important.

It may be noted, however, that chambering is rare on what are regarded as good oyster beds, and there is good reason to believe that the salinity variations over such beds range between about 30 and 34 per mille.

Chambering has also been observed in some deep-sea oysters, and, it may be presumed, from the operations of the same causes as in high estuarine situations. The conditions on deep-sea oyster beds are very different from those in high estuarine situations, but the breeding phenomena on the former beds are not known. It seems probable that breeding may not occur at all in some years in deep-sea beds, or that there is only a short breeding period (see Orton, Journ. Mar. Biol. Assn. vol. 12, p. 343), but that on the other hand growth is probably continuous over the greater part of the year. Since salinity variations would not be great on deep-sea beds it would appear that the reduction in bulk of the body due to breeding coincident with extensive shell-growth (see Hoek, Report on the Causes of the Deterioration in Quality of the Zealand Oyster, p. 90, s'Gravenhage, 1902) is the main cause of chambering in deep-sea oysters.

The view given above on the cause of chambering in oysters could readily be put to the test of experiment, but it would be preferable to carry out experiments on a large scale, beginning with thousands of young oysters. The economic importance of oysters is sufficiently great for the matter to be taken up by such large oyster-planters as are troubled with chambering. It will readily be seen from the argument given above that chambering is a minor pathological phenomenon, and that there is nothing to prevent the growth of a good well-fished oyster in a chambered shell, and, as a fact, excellent oysters do occur in chambered shells.

EDITH WORSNOP.
J. H. ORTON.

Marine Biological Laboratory,
Plymouth, December 4.

The Hardness of Vitreous Silica.

THE hypothesis proposed by Sir George Beilby to account for the hardening of metals by cold-working, and accepted by most metallurgists in this country, assumes the production of a vitreous phase of the metal by the breaking down of the crystalline structure during extensive deformation. It requires that the vitreous modification of a substance should be harder than the crystalline. Direct evidence on this point has rarely been obtained. Silica, however, suggests itself as a suitable substance for such a test, both the crystalline forms and the under-cooled glass being readily obtained in a form suitable for mechanical tests. The hardness of silica was carefully studied by Auerbach, who found a surface of vitreous silica to be less hard than either of the principal faces of quartz. Most commercial silica glass is, however, so weakened by the presence of numerous gas bubbles that any grinding test is likely to give low results for the hardness.

We have recently had the opportunity of examining a specimen of silica of unusual hardness. This was obtained by throwing a quantity of pure quartz sand on to the slag in an open-hearth steel furnace when the slag surface was at an exceptionally high temperature (1800° C. by the optical pyrometer). The sand melted, and formed a lenticular mass, which only mixed with the slag at its margin. On removing the product, a colourless, translucent mass of glassy silica was obtained, passing sharply into the dark slag. Analysis of the colourless mass gave 97·7 per cent. silica, 2·0 per cent. lime, and a trace of iron. A thin section between crossed Nicols was isotropic, with only a few scattered inclusions of minute crystals and some spherical bubbles.

Tests with a sclerometer, using a diamond point under a load of 400 grams, gave a broader scratch on a prism face of quartz than on a polished surface of the vitreous silica, but on account of the splintery nature of both scratches little reliance could be placed on the actual measurements. A fractured edge of the fused product distinctly scratched the prism faces of quartz, while natural angles of the latter failed to scratch the vitreous surface. Further tests were made with the scleroscope, an instrument in which the rebound of a diamond-pointed hammer falling from a height is measured. The following figures were obtained, all the specimens being embedded in pitch in the cast-iron cup provided with the instrument:

Polished vitreous silica	94
Quartz, prism face	91
Commercial vitreous silica . . .	82

The experiments are not conclusive, and a higher accuracy will be attempted, but it would appear that silica thoroughly fused at a high temperature is distinctly harder than crystalline quartz, and to this extent the experiments support Beilby's hypothesis.

COSMO JOHNS.
CECIL H. DESCH.

Sheffield, December 2.

Distribution of the Organ-Pipe Diatom, *Bacillaria paradoxa.*

IN the Notes in NATURE for September 29, 1921 (vol. 108, p. 163), it is mentioned that Mr. J. W. Williams and Mr. H. Weaver have found the curious organ-pipe diatom, *Bacillaria paradoxa*, in canals and pools in Staffordshire and Worcestershire. It may be of further interest to note that while leading a party of field naturalists on a seaside expedition to Altona Bay, near Melbourne, some years ago (*Victorian Naturalist*, vol. xxxiv., June 1917, p. 16), we found this same diatom very abundantly both in the sea and up the Kororoit Creek for a good distance, where the water was only slightly brackish. On examining the finds at home I was struck with the fact that, whereas the marine form was very active in its peculiar sliding movement, the brackish form was sluggish in contrast. It would be interesting to know whether other observers have found the fresh water to act as an agent for "slowing down." Probably the saline conditions of the water assisted the osmotic pressure which may induce the movement.

F. CHAPMAN.

National Museum, Melbourne,
October 24.

Speculation concerning the Positive Electron.

SIR OLIVER LODGE's interesting speculation, in NATURE of November 25, p. 696, as to the possible similarity of positive and negative electrons suggests an inquiry into the relative abundance of the lighter and heavier elements to be expected on this hypothesis. Considering the simplest case, that of hydrogen, let us assume that very large equal numbers of positive and negative electrons initially combine to form $N+n$ positive, and $N-n$ negative protons, and that the negatives immediately combine with an equal number of positives to form heavier nuclei, leaving $2n$ positive protons to form hydrogen atoms. Since in the combination of protons to form heavy nuclei the loss of mass by "packing" is apparently small, the ratio $\frac{\text{mass of hydrogen}}{\text{total mass of all elements}}$ should be very nearly equal to $2n/2N$, *i.e.* n/N.

The probability that, in the fortuitous formation of $2N$ protons, $N+n$ shall be positive and $N-n$ negative is $\frac{(2N)!}{2^{2N}.(N+n)!.(N-n)!}$. This is a maximum when $n=0$. Call this probability for an exactly equal distribution P, then the probability for any other distribution is $\frac{P.(N!)^2}{(N+n)!.(N-n)!}$, which, in the limit when N is very great, reduces to $Pe^{-\frac{n^2}{N}}$. It is hence highly improbable that n^2 should be large compared with N. If we assume that $n^2=N$ we should get a result of the right order of magnitude. On this assumption the relative concentration of hydrogen would be $1/\sqrt{N}$.

Whatever may be the case in other systems, we would certainly seem to be justified in assuming that, in the solar system, all, or almost all, the atoms are of the positive nucleus type. The number of protons constituting the solar system is about $1 \cdot 2 \times 10^{57}$, which would give a hydrogen concentration of the order of 4×10^{-29}. As the hydrogen in the terrestrial oceans forms 8×10^{-11} of the whole mass of the solar system, there is no need to enlarge upon the magnitude of the discrepancy. A similar argument might be applied tó the other light elements formed by the combination of positive and negative protons.

The above argument may be objected to on the ground that some negative protons would certainly combine with previously formed positive complexes. As, however, about half the complex nuclei first formed would be negative, so that some of the positive protons would be lost by combination with them, we would expect these effects to balance approximately, unless we assume that, when two unequal nuclei combine, the sign of the combination is determined by that of the larger constituent. On this hypothesis it is conceivable that, if the first set of nuclei formed happened to be positive, they might so direct the course of subsequent events by annexation of negative protons, and light negative nuclei, as to lead to the existing distribution of the elements.

HORACE H. POOLE.

Royal Dublin Society,
Leinster House, November 29.

The Hæmoglobin Distribution on Surfaces of Erythrocytes.

FROM time to time the point is brought home that factors should be discarded only when exact calculation proves them to be negligible. A case in point is the recent paper by Dr. K. Burker (Pflüger's *Archiv für die gesamte Physiologie*, vol. 195, p. 516). In this interesting paper it is shown that in mammals the weight of hæmoglobin per square micron of surface of the erythrocytes is apparently a constant equal to $31 \cdot 7 \times 10^{-14}$ gm. Dr. Burker has, however, assumed that the surface area of the cells is equivalent to twice the area of a circle having for its diameter the large diameter of the cell. The general opinion is that in mammals (the camel excepted) the shape of the cells is a bi-concave disc, having a circle for its horizontal projection, and a flat bi-concave ellipse for the vertical projection of which the minor axis is about one-third of the major axis (E. Ponder, Proc. Roy. Soc. 94B, p. 102). The surface area of such an erythrocyte would then be equal to that of an ellipsoid of revolution around the minor axis. It can be shown by the integral calculus that the area of such an ellipsoid (if the minor axis is equal to one-third the major) is $1 \cdot 09$ times as great as that of two circles with the major axis for diameter. Dr. Burker's constant is therefore equal to $31 \cdot 7/1 \cdot 09$ or 29×10^{-14} gm. hæmoglobin per square micron of surface of erythrocyte instead of $31 \cdot 7 \times 10^{-14}$ gm.

BENJAMIN S. NEUHAUSEN.

Department of Physiology,
Johns Hopkins University,
Baltimore, Md., November 24.

The Local Handbook of the British Association.

I HAVE just seen Mr. Bernard Hobson's letter in NATURE of November 4, p. 605. Mr. Hobson might have finished the quotation he gave from your review of the Hull Handbook which stated that "It approaches nearer to our ideal than that issued at any previous meeting. . . ."

Early last year Mr. Hobson wrote to me making various suggestions in connexion with the handbook, and I fancy I was able to tell him that they had all been carried out: he has now found some more. Of course no one will be able to meet the wishes of every member of the British Association in this way, but what is often forgotten is the fact that the local handbook is *presented* to the visitors *by the local committee*, and whether it is good or bad is scarcely the concern of a committee of the British Association. In our case something like 800*l.* was spent in producing a book which, we knew quite well, could not possibly be read, marked, learned, and inwardly digested during the meeting, but we felt that the book might be useful for reference after the return of the members to their respective homes.

I quite agree that an index and a geological map would have been an improvement; in fact, we went to considerable trouble in the preparation of a geological map of the Riding, but the printers' strike made its publication, indexing, etc., impossible. Only a few days before the Hull meeting none of the handbook was printed off, much was still in manuscript, and it was only by working day and night that a supply was ready for the use of the members. For the benefit of future meetings of the Association, may I suggest that the editor of the handbook should not be one of the local secretaries. Each of these tasks is quite sufficient for an ordinary human being, and for one to attempt both is almost bound to court disaster.

T. SHEPPARD.

Museum, Hull.

Occult Phenomena and After-images.

PROF. ANDRADE's experiments recorded in NATURE of December 23, p. 843, on the apparent movements of cardboard hands, suitably illuminated by dim light, are interesting in connexion with a phenomenon recently recounted to me by a coroner of long experience. It appears that members of the jury, when brought in to view a corpse, frequently declare that they have seen the body, sometimes of long standing, breathing. No doubt an apparent up and down movement of the naked thorax is induced in a way similar to that recorded by Prof. Andrade. It is possible that murderers brought into the presence of the corpse of their victim exposed in a dim light must frequently have seen such movements of the hands especially as they will probably stare fixedly at the body. Any apparent movement will of course be intensified by suggestion. This may account for many old superstitions.

Finally I should like to compliment Prof. Andrade on having described certainly two of the prettiest methods of demonstrating the movements of the visual purple. I find that the phenomena described by him are readily seen by people who have not been told what they are expected to see, an essential point in such experiments.

F. W. Edridge-Green.

London, December 26.

Experiments on Hardness and Penetration.

I am greatly interested in the letter on "A Curious Feature in the Hardness of Metals," by Mr. Hugh O'Neill and Dr. F. C. Thompson, which appears at p. 773 of Nature of December 9, for in my paper "Experiments with Clay in its relation to Piles," read before the Society of Engineers on March 10, 1919, will be found an account of the "pressure of fluidity" of clay. Briefly this may be described thus. When a horizontal disc resting on clay is gradually loaded it slowly sinks into the clay, each increment of load producing a corresponding increment of penetration, but when the load on the disc reaches a certain critical value the disc continues to sink at about ten times the speed *without* any further increase of the load. This load divided by the area of the disc I have called the pressure of fluidity of the clay. This quantity has been found, within a considerable range, to be independent of the area of the disc used for its determination. The only factor upon which it depends, in the case of the London clay used, is the percentage of water in the clay, and by this it is very greatly affected, as will be seen from the following equations, which fit the results closely within the ranges stated, and the table below.

From 28 per cent. to 38 per cent. of water; $p'=\frac{1073\times10^{10}}{(w')^7}$, where p' is the pressure of fluidity in grams per sq. cm. and w' is the percentage of water in the clay.

The same equation may be used with small error down to $w'=25\cdot7$ per cent., but with values of w' from 25·7 per cent. to 22·0 per cent. the relation is p (kilograms per sq. cm.) $=39\cdot5-1\cdot48w'$.

I have experimented with spheres in place of discs and have not detected any difference in the values of the pressures of fluidity thus determined. The reason for this is probably due to what other experiments have disclosed, namely, that the descending disc carries down with it the clay which was immediately under it at the start of the experiment, this stagnant clay forming roughly a hemisphere below the disc. Whether a disc or sphere is used, a clean hole is left behind.

Expecting to find a similar phenomenon in the case of metals, a corresponding experiment was made with cast lead. The result was the same. At a certain critical load the disc continued to sink into the lead without further increment of load. The pressure of fluidity of lead was thus found to be 1233 kilos per sq. cm., as recorded at pp. 152-4 of my fourth paper on "The Physical Properties of Clay," read before the Society of Engineers on June 12, 1922. From the rate of penetration (after the pressure of fluidity had been reached) and by a modification of Stokes' Law, the viscosity of the lead at 60° F. was found to be

$$7\cdot37\times10^{10}\text{ dyne-seconds per sq. cm.}$$

Taking the Brinell formula given by Messrs. O'Neill and Thompson, when the ball is below the surface of the material $d=D$, and the Brinell formula they give becomes

$$H=\frac{2L}{\pi D^2}. \qquad (1)$$

And when $d=D$ the Meyer formula becomes

$$L=aD^n. \qquad (2)$$

Substituting (2) in (1) we have

$$H=\frac{2aD^n}{\pi D^2}=\frac{2a}{\pi}D^{n-2}. \qquad (3)$$

The Brinell hardness number is the stress in kilograms per sq. mm. on the curved surface of the indentation.

The pressure of fluidity, p, is the critical load L divided by the area of the disc (or great circle of the ball). Thus:

$$p=\frac{L}{A}=\frac{L}{\frac{\pi}{4}D^2}=\frac{aD^n}{\frac{\pi}{4}D^2}=\frac{4a}{\pi}D^{n-2}. \qquad (4)$$

Hence p is seen to be equal to 2H, where $H=\frac{2L}{\pi D^2}$ and L is the critical load.

This result also immediately follows from the fact that in the case of the Brinell No. the load is divided by the area of the *curved* surface of the indentation, whereas in the case of the pressure of fluidity the load is divided by the projected area of the sphere, and the ratio of the area of the curved surface of a hemisphere to its flat surface is 2.

$$\text{As } A=\frac{\pi}{4}D^2, \quad \therefore D=1\cdot13\sqrt{A},$$

Therefore Meyer's formula

$$L=aD^n \text{ becomes } L=a(1\cdot13\sqrt{A})^n$$
$$=a(1\cdot13)^nA^{\frac{n}{2}}.$$

But in the case of clay, $L\propto A$, this being one of the most definite and carefully determined results. Consequently, if Meyer's formula is also true for clay, n must be $=2\cdot0$, in which case $L=a(1\cdot13)^2A=1\cdot275aA$, and $L/A=p=1\cdot275a$ or $a=p/1\cdot275$.

Using this relation the following values of a are obtained for London clay:—

Per cent. of Water.	Pressure of Fluidity. Kilos per sq. cm.	a.
37·8	0·107	0·083
37·0	0·128	0·100
31·0	0·320	0·251
30·0	0·527	0·414
29·0	0·600	0·471
28·0	0·846	0·663
25·4	1·938	1·521
23·6	4·700	3·69
22·0	7·200	5·65

A. S. E. Ackermann.

17 Victoria Street, Westminster, S.W.1,
December 11.

The Borderland of Astronomy and Geology.[1]

By Prof. A. S. EDDINGTON, F.R.S.

THE region in which geology and astronomy most conspicuously overlap is in the theories of the origin of our planet. We have, in fact, two main theories—one due originally to an astronomer, Laplace, and the other to a geologist, Chamberlin.

In the last century the evolution of a star seems often to have been regarded as something quite detached from the evolution of the stellar universe. Just as the birth and death of a man is an incident which can occur at any time in the rise and decline of the human race, so it was thought that the birth and extinction of a particular star formed merely a detached incident in the course of progress of the stellar universe —if, indeed, the universe was progressing in any particular direction. Thus it was a natural belief that the stars died out and were re-formed by collisions of extinct stars; and that the matter which now forms the sun had undergone many alternations of incandescence and extinction since things first began. But this view is quite at variance with the general tendency of sidereal astronomy in the present century. We have come to recognise that the stellar system is one great organisation, and that the stars which are shining now are more or less coeval with one another. Everyone would admit that Mars and Jupiter were formed as parts of one process of evolution—not necessarily at the same moment, but each formed as the process reached the appropriate stage; and similarly we now believe that it was one process of evolution sweeping across the primordial matter which caused it to form itself into stars; and these original stars are the actual stars which we see shining now. No doubt the evolution did not develop at the same rate in all parts of the universe, and there are probably places where stars are still being formed; but you will see that this view is entirely different from the other view that stars were being formed individually by haphazard collisions of dark stars, so that each was an independent formation, having no time-connexion with other stars.

This view has been forced on us partly by direct evidence of organisation among the stars, pointing to a common origin for large groups of stars. We notice scattered groups such as the Hyades, which have almost exactly equal and parallel motions. Clearly it would be impossible to form such a group if each star were the product of an accidental collision. The only way in which a common motion like this can arise is by associated development from some nebula or other diffuse distribution of matter. The connexion is clearly a connexion of common origin. Again, practically all the bright stars of Orion form a similar group, having common motion; and, moreover, they have all reached a similar stage of evolution. They are connected with the great Orion nebula, the faint extensions of which fill up nearly the whole constellation. It is obvious that here we have to deal with a single evolutionary development. But another point which militates against a collision theory is the extreme rarity of collisions and close approaches. The distances separating the stars are enormous compared with their own dimensions. Sir Frank Dyson once used the illustration of twenty tennis-balls, distributed at random throughout the whole interior of the earth, to give a model of the density of distribution of the stars. It has sometimes been objected that we do not know how many extinct stars may be wandering about and colliding. Dyson's twenty tennis-balls represent only the *luminous* stars; there may, for all we know, be millions of *dark* bodies ready to be fired into incandescence by collision. I think, however, that there is now good evidence, based on the dynamics of stellar motions, that the dark stars cannot greatly outnumber the luminous stars—probably not ten times and certainly not a hundred times. (If they were more numerous than that, the average velocities of stars would, owing to the gravitational attraction, be much higher than is observed.) That argument, then, is no longer valid. Taking a very liberal view of the kind of approach that can be held to constitute a collision, it is estimated that a star would only suffer collision once in 10^{14} years.

Thus the astronomer is not predisposed to look favourably on a hypothesis of the origin of the solar system which postulates anything of the nature of a collision. He has the conception of an orderly development of the stars crystallising out of the primordial material, and, unless perhaps in exceptional cases, following an undisturbed course of development. We hope for a theory that will show us the star after its first isolation from surrounding material spontaneously developing the system of planets.

It now appears almost certain that, whether the original matter was gaseous or whether it was composed of meteors, it must at an early stage in the star's history have been completely volatilised into gas. This was while the star was extremely diffuse, and, for example, before the planets separated from it. This means that the material now forming a planet has at one time passed through the furnace, and has cooled down from a gaseous stage. How far that has a direct bearing on geology I cannot say, since I have nothing to guide me as to the course of its subsequent chequered history. I do not say that the earth was a gaseous body when it first became recognisable as an independent planet, but I am convinced that its material was at one time merged in a completely gaseous sun.

It may be of interest to indicate why it seems so probable that a star in its early diffuse state is gaseous and not meteoric. The stars are known to be of closely similar mass. There are occasional exceptions, but probably 90 per cent. of them are between one-half and five times the sun's mass. We have no explanation of this uniformity if they are initially merely aggregations of solid meteors; but we have a very exact explanation if they are gaseous. In fact this critical mass round which the actual masses of the stars cluster so closely is predicted by the theory of equilibrium of spheres of gas, using only well-known physical constants determined in the laboratory. The crucial factor is radiation-pressure, which is inappreciable in smaller masses, and almost suddenly takes control between one-half and five times the sun's mass.

[1] A lecture delivered before the Geological Society of London on November 21.

There can be little doubt that large radiation-pressure, tending to overcome gravity, conduces to instability, so that larger masses have small chance of survival. Somewhere about one-half the sun's mass the radiation-pressure no longer counts seriously, so that there is no tendency for the primitive material to break into smaller units.

The existence of radioactive minerals on the earth seems to supply another reason for believing that its material was originally subjected to high temperature or to physical conditions of a different order from those now prevailing. In radioactivity we see a mechanism running down which must at some time have been wound up. Without entering into any details, it would seem clear that the winding-up process must have occurred under physical conditions vastly different from those in which we now observe only a running-down. The only possible guess seems to be that the winding-up is part of the general brewing of material which occurs under the intense heat in the interior of the stars.

The trend of this argument has been against the Chamberlin-Moulton hypothesis and in favour of some form of nebular origin of the solar system. It is, of course, accepted that the details of the original nebular hypothesis of Laplace require modification. Also the word nebula is meant to signify diffuse gaseous material in general, and has no immediate connexion with those objects which we see in the sky, and call nebulæ more particularly. There is still controversy as to what process of evolution is represented by the spiral nebulæ which are seen in such numbers—what they will ultimately turn into; but the controversy is whether the spiral nebula will give rise to a cluster of a few hundred stars, or whether it will turn into a stellar universe on the same scale as the great system of some thousands of millions of stars which forms our galactic system. There is now no suggestion that it has anything to do with the formation of so insignificant a system as the solar system. But in preferring the nebular hypothesis to that of Chamberlin and Moulton, it is necessary to make a certain reservation. We have hitherto taken it for granted that the formation of a system of planets is a normal feature of the evolution of a star. Most of my arguments have referred to the development of stars in general, and would become irrelevant if it could be admitted that the solar system were an exceptional formation violating ordinary expectation.

We know that at least a third of the stars are double stars, and I do not think there is any reason to think that planetary systems would be formed when the evolution takes that course; but until recently it was taken for granted that the remaining single stars would generally (or at least frequently) be the rulers of systems of planets. Jeans has recently pitched a bombshell into the camp, suggesting that the solar system is a freak system—the result of a rare accident, which could only happen to one star out of a very large number. He found no way of accounting for it as a normal process. I have not the specialist knowledge necessary to criticise the details of the working of the nebular or of the planetismal theory of development, but before regarding Jeans's argument as conclusive (he himself makes reservations) I should be more satisfied if the effect of radiation-pressure had been taken into account. It is fairly clear that radiation-pressure plays a great part in the separation of nebulous matter into stars, and although I have no definite reason to think that it can account for the separation of planets from the sun, I do not feel satisfied that we have got at the whole truth until that point has been duly examined.

Supposing, however, that we are forced to accept Jeans's suggestion that the solar system is a freak system, some of my objections to the Chamberlin-Moulton hypothesis are removed. I cannot admit that the conditions of collision which that hypothesis requires are normal features in the formation of stars; but they might have happened occasionally in the history of the universe, and produced the solar system, the sun being thus as an exceptional star born out of due time. But if my arguments against Chamberlin's hypothesis fall to the ground, there are probably other astronomers prepared to attack it in other directions.

The new views as to the age of the earth are now pretty well known to geologists. I may sum them up briefly in the statement that Lord Kelvin's estimate of the extent of geological time need not now be taken any more seriously than Archbishop Ussher's, and that the geologist may claim anything up to 10,000 million years without provoking a murmur from astronomers. Although there may still be some difficulties about the exact source from which the vast heat-energy the stars pour out into space is derived, it is now clear that the Helmholtz contraction-theory is inadequate to give the necessary supply. The astronomer has no such precise means of measuring geological time as the physicist has now discovered by the analysis of radioactive minerals; but he can add his contributory evidence that the sun, and presumably therefore the earth, is much older than Lord Kelvin allowed. In the Cepheid variable stars it seems possible to measure the actual rate at which evolution is proceeding—the rate at which the star is condensing from a diffused state to a denser state. The star is believed to be pulsating, and as it expands and contracts the light varies in quantity and character. In a pulsating gravitating mass the period is proportional to the inverse square root of the density, so that by observing the rate at which the period is changing we can deduce the rate at which the density is changing. I may add that the law that the period depends on the inverse square root of the density is very closely confirmed by comparing the values for the various Cepheids. In this way we find that for the best observed of these stars, δ Cephei, the density is changing 500 times slower than the contraction hypothesis assumes. It would, of course, be risky to assume that the same proportion holds at all stages of the evolution of a star; but it suggests that Lord Kelvin's estimate of 20 million years for the age of the sun might well be multiplied by 500 to give 10,000 million years. At any rate, the Cepheid observations show that the stars must have some other source of energy besides contraction.

I suppose it must be a matter of interest to geologists whether the intensity of the sun's heat has been constant or whether it was at one time hotter than now. I think we can say fairly definitely that the sun was formerly much hotter. There must have been a time when the sun's heat was from 20 to 50 times more intense than it is now. That would no doubt have made a great difference to many geological processes. Unfortunately, I cannot say whether it occurred in known geological epochs. It must have occurred after the earth had begun to exist as a separate planet; but whether it was before or after the sequence of geological strata began to be laid down I have no idea. It would not be unreasonable, however, to expect that in the early geological times the sun was several times hotter than it is at present.

After the evolution of the solar system, we naturally turn to consider the evolution of the earth-moon system. My impression is that nothing in recent progress suggests any doubt that the beautiful theory of Sir George Darwin is substantially correct. The main features are that the moon at one time formed part of the earth, and broke away. At that time the rotation period of the earth was between 3 and 4 hours, and the cause of the fracture was that the solar tidal force synchronised with a free period of natural vibration of the earth; owing to resonance the tidal deformation of the earth continually increased until rupture occurred. The earth's period of rotation has since lengthened to 24 hours, owing to frictional dissipation of energy by lunar and solar tides; and the back-reaction of the lunar tides on the moon has caused the moon to recede to its present considerable distance. All this has well stood the test of searching criticism, and must be considered as extremely probable. Modern research has added two contributions; it enables us to calculate the magnitude of this tidal friction at the present time, and it enables us to locate more exactly the region where the frictional dissipation is occurring.

I believe it was Darwin's view that the tides most potent in wasting energy were not water-tides but tides in the solid earth; that is to say, we have to do with deformations of the whole earth under the tide-raising force of the moon's attraction. Undoubtedly these deformations of the earth occur, but everything turns on whether the process of deformation is attended with serious friction. H. Jeffreys has pointed out that the phenomenon of latitude variation is accompanied by similar deformations of the earth; and in this case it is clear that the friction is inconsiderable, for otherwise the deviations of the pole from the symmetrical position would be damped out almost at once. It seems, therefore, very unlikely that the solid tides can have had much effect in the process of tidal evolution of the earth-moon system. Ocean tides are likewise of small effect as Darwin himself had seen. The modern conclusion is a very curious one; it is in the land-locked shallow seas that nearly all the mischief occurs. This was discovered by G. I. Taylor, who found that the Irish Sea alone is responsible for $\frac{1}{50}$ of the whole amount required by observation. The remaining land-locked basins on the earth are probably capable of making up the necessary total.

The actual rate at which the earth's rotation is being slowed down at the present era can probably be deduced with fair accuracy from the records of ancient eclipses. The day is lengthening about one-thousandth of a second per century or 1 minute in 6,000,000 years. At this rate we should have to go back more than 10,000 million years to the time when the day was between 3 and 4 hours and the moon was born. Since the rate depends on the accidental circumstance of occurrence of shallow seas no definite prediction can be made; but allowing for the much greater effect of the tides when the moon was nearer to us, it is difficult to date the birth later than 1000 million years ago.

Had the earth a solid crust at the time the cataclysm happened? I cannot tell at all. But if it suits geological theories I can see no objection whatever to the hypothesis that the earth had a solid crust at the time. No cohesion of the crust would seriously resist the enormous forces involved when the resonant vibration got started. It would not be appreciably more difficult than the disruption of a molten earth. The view that the Pacific Ocean is the hollow left at the place where the moon broke off seems tenable unless geologists find objection to it; and in that case we may suppose that the water now collected in the hollow formerly covered the earth—or most of it. This change of condition of the earth may (or may not) have happened within geological times. When the earth was covered with water there would be no land-locked seas and no appreciable tidal friction from the sun (the moon being not yet born), so that we can allow a long previous history during which the length of day was nearly constant at 3 or 4 hours. That rather helps to make the whole theory self-consistent.

These speculations stand very much as they did when Darwin put forward his theory. But I am tempted to add further speculations arising out of the location of the frictional dissipation. (I am taking advantage of the great opportunity for speculation which this address affords. Ordinarily I am restrained, because people would ask, What facts can you produce in support of your speculations? But here I am asking the question, Have you any facts which seem to support them? If not, by all means let them drop.) The frictional dissipation acts as a brake on the earth's rotation, and we now feel confident that the brake is a surface-brake applied at certain points on the earth's surface where the favourable conditions exist. The retarding force is transmitted to the earth's interior, and so delays the rotation as a whole; but unless the material is entirely non-plastic there will be a tendency for the outer layers to slip on the inner layers. I do not know how much the material a few hundred miles below the surface would be expected to give under the strain; it may be inappreciable, but I will assume that though small it has some effect.

We have then the whole crust slipping from east to west over the main part of the interior. Probably it would go very stickily, sometimes arrested by a jamming which would hinder it for a time and then going on more easily. That is helpful in explaining certain astronomical observations. There are irregularities in the motions of heavenly bodies, noticed particularly in the swift-moving moon but shown also on a smaller scale in the sun and planets, which appear to indicate that our standard timekeeper, the earth, is a little irregular. Now, of course, it is the rotation of the *surface* of the earth which determines our standard time. I find it difficult to believe that there can be irregular variations in the angular velocity of the earth as a whole; but it seems less difficult if the variations are merely superficial, due to the crust sliding non-uniformly on the interior. I have even entertained the wild idea that the motion of the magnetic poles might be due to this cause; the magnetism being constant in the interior but with the axis emerging at changing points of the crust as the crust slips over the inner magnet. Unfortunately, so little seems to be known about the motion of the magnetic poles that I have not even been able to make out whether the motion is from west to east as this theory definitely requires.

What interests the geologist more nearly is that the brake is applied only at certain areas on the surface, so that there would be a tendency to crumple the crust more particularly to the west of these areas. It is unfortunate that shallow seas are necessarily the least permanent features of the earth; otherwise I would have asked whether the geologists had evidence of special crumpling in such areas.

I have regarded the crust as fairly mobile from east to west. I suppose the geologists would also like it mobile from north to south in order to have glacial periods in those portions which are now near the equator. It is not possible to hold out much encouragement for such an idea, because we cannot imagine any force acting from north to south. Still if the crust, which is being urged by the east-west force of tidal friction, is resisted by obstacles it may be deflected, finding that say a south-west track offers less resistance. In a long enough time almost any displacement may have happened, granting my hypothesis that the connexion of the crust to the interior is reasonably plastic. So I cannot forbid this possible interpretation of glacial periods in the earlier geological times.

I am sure that it will not be supposed that, in presenting the astronomical side of these questions which belong both to geology and astronomy, I have any intention of laying down the law. The time has gone by when the physicist prescribed dictatorially what theories the geologist might be permitted to consider. You have your own clues to follow out to elucidate these problems, and your clues may be better than ours for leading towards the truth. We both recognise that we are adventuring in regions of extreme uncertainty where future discoveries will probably lead to various modifications of ideas. Where, as in the new views of the age of the earth, physics, biology, geology, astronomy, all seem to be leading in the same direction, and producing evidence for a greatly extended time-scale, we may feel more confidence that a permanent advance is being made. Where our clues seem to be opposed, it is not for one of us to dictate to the other, but to accept with thankfulness the warning from a neighbouring science that all may not be so certain and straightforward as our own one-sided view seemed to indicate.

Nature and Reproduction of Speech Sounds.[1]

By Sir RICHARD PAGET, Bart.

ALL the characteristics of English speech—the vowels and diphthongs and consonant sounds—can be produced—as breathed or whispered speech—without using the larynx at all; so that in the use of the English language (at least) it may be said that the larynx is not an essential organ of speech. The function of the larynx is to give carrying power and inflexion to speech, and melody to song—it has nothing to do with the essential characteristics of speech.

If any one with a normal "ear for music" will whisper the words "Noah's rather at sea"—thinking of the sounds rather than of the sense—they will hear

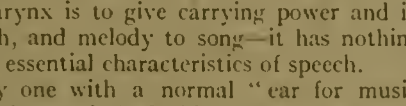

FIG. 1.

an ascending arpeggio something like the phrase shown in Fig. 1. The exact notes heard in each case will depend on *how* the individual person pronounces the vowel sounds in question.

These whispered or breathed notes are formed, as is well known, by the resonance of the cavity of the mouth, and they are varied for each different vowel sound by altering the size of the cavity and the opening of the mouth, mainly through the operation of the tongue and lips. With many of the vowel sounds, namely, i (eat), ei (hay), e (men), æ (hat), o (not), and in some types of ɑ (calm), two simultaneous resonant notes have been heard by many investigators, but the remaining principal vowel sounds, ɔ (all), ou (no), and u (who), have been generally supposed to be characterised by a single resonance.

Some observations made by me at the beginning of this year, using my own breathed vowel sounds, indicated that in *every* case the mouth—or rather the oral cavity as a whole, from the larynx to the lips—actually gives *two* simultaneous resonances for *each* vowel sound. It appeared that these pairs of resonant notes are not fixed in pitch for any one vowel sound, but might vary over three or four semitones—and sometimes even more—without a very appreciable change in the character of the vowel.

The resonances heard in the use of my own voice are set out in the accompanying chart, in which the vertical scale represents semitones of the equal temperament scale, and the vowel sounds are represented in the notation of the International Phonetic Association (Fig. 2).

It will be seen that i (eat), I (it), ei (hay), e (men), æ (hat), ɐ (earth), ə (sofa), ʌ (up), and ɑ (calm) form very nearly a converging series—the upper resonances falling by steps of 1 to 3 semitones, while the lower resonances are more active and take larger jumps—

[1] Substance of a lecture delivered at University College, University of London, on October 18.

not all in the same direction. From ɑ (calm) onward the resonances go down, as it were, hand-in-hand, keeping an equal distance of about 8 semitones apart; and it is possible, owing to this fact, that they have not been generally recognised as separate resonances.

The double resonance of the oral cavity when forming the vowel sound u (who) may be demonstrated by the clapping method (see NATURE, March 16, vol. 109, p. 341); also the possibility of varying both resonances independently at the same time. Similarly, the independence of the larynx note and the front resonance may be illustrated by simultaneously humming and whistling a convergent scale.

Having identified the various resonances on which

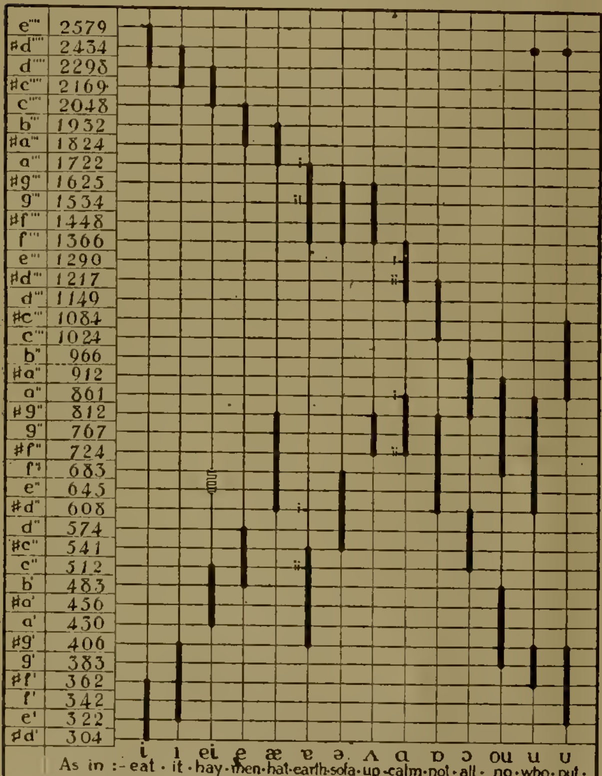

FIG. 2.—Vowel resonance chart. The horizontal dashes on the thick vertical lines denote the actual resonances of the models; the numerals i, ii denote successive models of the same vowel.

the production of the breathed vowels appeared to depend, the attempt was made to reproduce these vowel sounds by constructing some form of resonator which had resonances identical with those of the human mouth when a stream of air was blown through it. It seemed reasonable to expect that, if this could be done, the breathed vowel sounds would be reproduced. Models in plasticine were therefore made, the internal form of which very roughly imitated that of the human mouth and throat, except that the back portion corresponding to the pharynx was, for convenience, shortened and made more bulbous.

With this and similar models a number of experiments were made to test the effects of various alterations of the internal form—such as are actually made in the human mouth by the movement of the tongue, lips, etc.—and to discover the rules for tuning the instrument. An artificial larynx was made of a rubber strip lying across a flattened air passage—on the principle of the reed instrument which boys make with a blade of grass held between their two thumbs. When this reed or larynx was fitted to the back orifice of the model and blown, the model gave a voiced vowel.

The rules for tuning these models may be shortly summarised as follows: Enlarging the mouth generally raises both resonances. Increasing the projection of the lips or reducing the size of the mouth lowers both resonances. Raising the front of the tongue upwards or forwards raises the upper resonance but lowers the lower resonance. Pressing the back portion of the tongue backwards—so as to reduce the capacity of the back cavity corresponding to the human pharynx and to prolong the passage between the front and back cavities of the mouth—raises the lower resonance but lowers the upper resonance.

The experiments in tuning the plasticine cavities eventually made it clear that the human mouth, when making vowel sounds, always acts as *two separate "Helmholtz" resonators connected in series*—one behind the other—the back resonator being formed by the pharynx, the back of the tongue, and soft palate; the front resonator being formed by the front of the tongue, the hard palate, and lips; and the passage between the two resonators being formed by a hump in the middle of the tongue which approaches the roof of the mouth. By humping the tongue in different positions—forward or backward—the relative sizes of the front and back resonators can be altered at will, while the tuning can further be modified over a wide range by varying the opening of the mouth.

The resonant note of a cavity with an orifice to the open air depends, as is well known, on the relation between the volume of the cavity and the size of its orifices. The larger the cavity the lower the note; the larger the orifice the higher the note. With a resonant cavity having a neck—such as the neck of a bottle—the resonant pitch also depends on the length of the neck, being lower as the neck is made longer, and higher as the neck is shortened.

It follows from this that when two such resonant cavities are joined together, each one becomes, as it were, a neck to the other, and therefore influences its pitch. The effect is always to lower more or less the resonance of the neighbouring resonator according to the relation of the relative sizes of the two, and of the relative sizes of the connecting opening between the resonators and the opening to the air of the front resonator. The pitch of the resonators was ascertained by tapping them and listening to the resonant notes, or by blowing across the open mouth.

Each of the plasticine models (Fig. 3) made on this principle gives two resonances corresponding to a separate vowel sound. When the various models are blown in succession, first by mouth and afterwards for ɐ (earth) and ɔ (all) by bellows, the vowel characters are made more recognisable by covering and uncovering the mouth of the model by hand during blowing, so as to give an associated consonant (m or w). It was thus demonstrated that the vowel sound remains appreciably constant however much the pitch of the larynx note is altered by varying the air pressure.

Instead of putting the two resonators in series, as already described, they may be placed in parallel—side by side—with a single larynx having a forked or bifurcated passage to communicate with each of them. Two models made on this principle—one tuned to give i (eat) ♯d''''2434 and f'342 and the other to give ʌ (up) g'''1534 and ♯g''812—when blown emit vowel sounds practically the same as those given by the corresponding resonators in series with a single mouth.

Certain vowel sounds can be produced by a single cylindrical or ovoid resonator. An egg-shaped plasticine resonator, when blown *through* by means of a small hole at the back, gave three resonances—c''512, g'''1534, and c''''2048, and a vowel sound intermediate between e (men) and ɐ (earth).

Double resonances may also be obtained from a cylindrical resonator closed at one end and blown through a small orifice in the closed end. A reed-actuated cylindrical resonator of variable length (lent by Prof. D. Jones) gave a series of vowel-like sounds, and a plasticine cylindrical resonator gave ʌ (up) with resonances ♯g'''1625 and ♯g''812.

These cases of double resonances produced by a single resonator are interesting as affording a possible explanation of Helmholtz's statement, that he had obtained certain vowel sounds by the use of a single resonator.

The reproduction of the various consonants appears to depend on exactly the same principles, namely, the combination of separate resonators (sometimes more than two), and it has been found possible to reproduce all the English consonant sounds also in this way. The principal difference is that, whereas with the vowels (other than the diphthongs) the resonances are more or less fixed during the voicing of each vowel, with most of the consonants the resonances are rapidly changing, and the consonant sound depends to a large extent on the rate of change.

To summarise these experiments and conclusions: We have seen that each of the English vowel sounds, when whispered or breathed, appears to consist of two musical notes due to the air current from the lungs blowing through the cavity of the mouth and throat. The cavity as a whole is divided up by the tongue into two resonating cavities—one behind the other—each of which produces its characteristic note.

When, instead of passing a steady current of breath through these resonators, we pass a current of air which has previously been set in vibration by the action of the larynx, the sound of the larynx note is coloured by the two resonators respectively and acquires the character which we recognise as voiced vowel sound.

The two resonances which characterise each of the different vowel sounds are not absolutely fixed in pitch for each vowel sound but may vary over several semitones; the tuning of the resonances is performed, in the mouth, mainly by the action of the tongue and lips, and is quite independent of the vibrations of the larynx.

In models, the double resonance of the human mouth can be reproduced by pairs of Helmholtz resonators joined together in series (making proper allowance for the reaction of each resonator on the resonating pitch one of the other) or by placing the resonators in parallel, side by side, so as to produce a double-mouthed model. When the resonators are driven tandem, the leader and wheeler may be counterchanged—so that, for example, the lower resonance is given by the front resonator instead of by the back, and *vice versa*.

FIG. 3.—Plasticine resonators.

It follows that it should be possible to write down any vowel sound in musical notation, and to reproduce it by means of a suitable instrument designed to give any required pair of resonances, either in series or in parallel. It also follows that every one who can recognise vowel sounds must have a perfect ear for music, and an almost absolute sense of musical pitch.

Obituary.

C. L. WRAGGE.

BY the recent death of Mr. Clement L. Wragge, formerly head of the Weather Bureau at Brisbane, at Auckland, New Zealand, meteorology has lost an enthusiastic worker. Mr. Wragge was born at Stourbridge on September 18, 1852, and was educated at Uttoxeter Grammar School. After a short period of service in the Surveyor-General's department at Adelaide, he returned to England, where he founded several meteorological stations in North Staffordshire. When the Scottish Meteorological Society wished to establish a meteorological observatory on Ben Nevis at 4400 feet above sea level, they were fortunate in securing the services of Mr. Wragge, who during the summers of 1881 and 1882 daily ascended the mountain and took regular observations. The Scottish Meteorological Society, in an appeal for public funds to found a permanent observatory on Ben Nevis, referred to "the observations made by Mr. Wragge with such skill, endurance, and enthusiasm during the last two summers on Ben Nevis." That very considerable endurance was required for the work was graphically shown in an article in the *Times* for September 1, 1881.

Returning to Australia, Mr. Wragge served as Government Meteorologist for Queensland from 1887 to 1902, and he established the Weather Bureau at Brisbane, as well as high-level meteorological stations on Mount Wellington and Mount Kosciusko (7336 feet).

Mr. Wragge was an enthusiastic devotee of map meteorology, and in tracing the movements of cyclones and anticyclones he was accustomed to give these systems Christian names in his official reports. His views and methods, especially in later years, were frequently unorthodox.

DAVID LINDSAY.

ONE of the pioneer explorers of Australia has passed away recently at Port Darwin in the person of Mr. David Lindsay. Born in June 1856 at Goolwa, South Australia, of Scottish parents, Mr. Lindsay entered the State Survey Department as a youth, and in 1883 was selected to lead an expedition to Arnhem Land.

In 1888 Lindsay rode across the little known interior of the continent taking only a native boy as companion. His route took him to the Macdonnell Ranges, to which he returned shortly afterwards for more detailed examination. Mr. Lindsay's most fruitful expedition was in 1891, when he was chosen to lead the expedition equipped by Sir T. Elder for the exploration of the great Victoria desert of Western Australia. Using camels for transport, he crossed 550 miles of desert in 35 days and was able to amplify the work of E. Giles, who had crossed that district fifteen years previously. On his return Mr. Lindsay directed attention to the existence of large auriferous areas in the interior. The outcome of his report was the development of the West Australian goldfield, which he continued to explore for some years.

At a later date Mr. Lindsay returned to the examination of the Northern Territory and in 1913 was nominated to a Commonwealth Commission charged with considering the economic development of the north. In 1920 he reported the discovery of large tracts of well-watered land which had previously been regarded as desert, and he directed attention to the possibilities of cotton growing in the Northern Territory.

Current Topics and Events.

THE list of New Year honours includes the names of the following men distinguished by their scientific work or associations :—*Knights* : Prof. D. Drummond, Vice-Chancellor of the University of Durham ; Dr. W. H. Hamer, Medical Officer of Health for London ; and Dr. B. H. Spilsbury, hon. pathologist to the Home Office. *C.B.* : Dr. F. J. H. Coutts, Senior Medical Officer, Ministry of Health. *C.I.E.* : Dr. N. Annandale, director of the Zoological Survey of India ; Lieut.-Col. A. T. Gage, Indian Medical Service, superintendent of the Royal Botanic Garden, Calcutta, and director of the Botanical Survey of India, Bengal ; and Mr. F. A. Leete, Chief Conservator of Forests, Burma. *K.B.E.* : Prof. D. Orme Masson, F.R.S., professor of chemistry in the University of Melbourne. *C.B.E.* : Dr. J. W. Evans, F.R.S., a member of the governing body of the Imperial Mineral Resources Bureau ; and Mr. F. E. Smith, F.R.S., director of Scientific Research, Admiralty.

IT is gratifying to learn that Pasteur's centenary was celebrated at Lahore (India) on November 22 last, under the auspices of the Society for Promoting Scientific Knowledge. A conversazione was held at the rooms of the society and demonstrations given relating to Pasteur's researches. Great interest was taken by the public in the exhibits relating to crystals, silk-worms and their diseases, and microbes of various kinds shown under the microscopes. This was followed by a public meeting, at which Prof. B. L. Bhatia, president of the society, spoke on Pasteur's work in the biological field. Principal A. S. Hemmy, of the Government College, and Lieut.-Colonel C. A. Gill, of the K.E. Medical College, delivered speeches relating to Pasteur's work in the domains of chemistry and bacteriology respectively.

THE latest accounts of the Chilian earthquake of November 11 are mainly concerned with the destructiveness of the shock and accompanying sea-wave. The *Times* for December 28 contains the report of a correspondent who visited Copiapo and Vallenar five days after the earthquake. The meizoseismal area is sparsely populated, the towns within it containing only a few thousand inhabitants, most of whom dwelt in low adobe or wooden houses, and this no doubt accounts for the comparatively small loss of life. At Vallenar, which suffered most, there is not a house left standing that is fit to live in, yet, out of a population of 5500, not more than 600 persons were killed and a thousand injured. Interesting photographs, showing the completeness of the destruction by the sea-waves at Coquimbo and Chañaral, are reproduced in the *Times* for December 19 and 28.

AT the meeting of the London Mathematical Society on January 18 at 5 o'clock, in the rooms of the Royal Astronomical Society, Burlington House, Mr. L. J. Mordell, reader in pure mathematics in the University of Manchester, will lecture on "An Introductory Account of the Arithmetical Theory of Algebraic Numbers, and its Recent Developments." Members of other societies, or any one who wishes to learn something concerning the theory of ideal numbers, will be welcomed.

A TRIBUNAL of investigation into the agricultural problem has been appointed as follows : Sir William Ashley, professor of commerce and vice-principal of the University of Birmingham ; Prof. W. G. S. Adams, Gladstone professor of political theory and institutions, Oxford ; and Prof. D. H. MacGregor, Drummond professor of political economy, Oxford.

Mr. C. S. Orwin, director of the Institute for Research in Agricultural Economics at Oxford, has been appointed agricultural assessor to the tribunal, and Mr. D. B. Toye, of the Ministry of Agriculture and Fisheries, will act as secretary.

It is announced that Messrs. Ashton and Parsons, Limited, have made to Guy's Hospital the generous gift of 2600*l*., to be paid in six and a half yearly instalments of 400*l*. each. This money is to be spent in research on diabetes and related metabolic disorders, and to be called a Parsons fellowship. At the present time, much work is required in investigating the properties and methods of preparation of extracts of the pancreas, one of which is known as "insulin." This endowment will assist to a notable degree the work already for some time in progress at Guy's Hospital in connexion with the pathology of diabetes.

Prof. W. M. Flinders Petrie has consented to give a lecture on "Royal Burials in Egypt," with special reference to recent excavations in Egypt, on Tuesday, January 23, at 5.30, in University College, London. The lecture will be illustrated by lantern slides, and the proceeds will be given to the St. Christopher's Working Boys' Club, which is connected with the Union Society and Women's Union Society of the College. A leaflet containing full particulars as to the prices of the tickets can be obtained by sending a stamped addressed envelope to Dr. Walter Seton, University College, Gower Street, W.C.1.

The Council of the Royal Statistical Society will, in November next, award the Frances Wood Memorial Prize, value 30*l*., for the best investigation of any problem dealing with the economic or social conditions of the wage-earning classes, the subject to be chosen by the competitor and treated on statistical lines. Competing essays (which must be either printed or typed, and accompanied by copies of all statistical tabulations), must be sent to the Honorary Secretaries of the Royal Statistical Society, 9 Adelphi Terrace, W.C.2, not later than July 1, 1923.

The *Times* reports that a wireless message has been received *via* the radio station at Spitsbergen from Capt. Wisting, of Amundsen's Norwegian North Polar expedition. The *Maud*, which left Cape Hope, Alaska, on July 26 for her drift across the polar basin, met pack ice in about lat. 70° N. Pushing through the ice the ship was near Herald Island on August 7, and on August 22 was frozen into the pack in lat. 70° 20′ (? 72° 20′) N., long. 175° 25′ W. The drift first carried the vessel back to lat. 72° N. and then to lat. 73° N., and finally due west. On December 15, when the message was despatched, the *Maud* was in lat. 73° 20′ N., long. 173° W. (? E.). On September 26 the *Maud* was exposed to heavy pressure but rose uninjured, the ice meeting below her. The message reports that fine weather has been experienced and that scientific work is proceeding satisfactorily. Contrary to expectation, animal life is scanty, but a few seals and two bears have been secured. This is the first message beyond two brief weather reports that has been received since the *Maud* left Alaska. Capt. Amundsen is wintering in Alaska ready to attempt his flight to Spitsbergen next summer.

The Research Medal of the Worshipful Company of Dyers has recently been awarded to Prof. G. T. Morgan for a dissertation on the co-ordination theory of valency in relation to adjective dyeing. This comprehensive theory of chemical affinity, propounded originally by A. Werner of Zürich, offers a means of correlating many of the facts observed in the dyeing of textile fibres with mordant or adjective colouring matters. The tinctorial effects produced are due to the formation within the fibres of insoluble coloured salts or lakes which in general are characterised by the following properties: sparing solubility in aqueous solutions, exceptional shade and fastness of colours, resistance to chemical reagents, and an inhibition of the ordinary analytical reactions of the metallic bases implicated in the lake complex. By the use of a cobaltammine reagent, Drs. Morgan and Main Smith have shown that in three series of adjective dyes—the quinoneoxime dyes, the alizarin series, and the azosalicylic acid dyes—the formation of a complex lake is due to the presence in the adjective colouring matter of a characteristic radical—the so-called "chelate" group—which has the distinctive property of satisfying completely the chemical affinity of the metallic component of the lake. These researches are being extended to other natural and synthetic adjective colouring matters.

At the end of the recent gliding week on the South Downs, the German duration records were broken by a Frenchman, M. Alex. Maneyrol, who stayed in the air 3 h. 22 m. The machine used in this feat was a Peyret Tandem Monoplane, and it was remarked at the time that this machine recalled the form of aeroplane constructed by S. P. Langley many years back. In a note issued by the Smithsonian Institution on November 28, 1922, reference is made to this vindication of Langley's design of a flying machine, and a short account is given of the history of the researches conducted by Langley. He began in 1887, and by 1892 had evolved a small "aerodrome" model. In May 1896 a model flew for $1\frac{1}{2}$ minutes (a photograph of this flight accompanies the note). Work on a full-sized machine began in 1898, and was supported by the War Department, Board of Ordnance and Fortification, U.S.A. A machine was ready in 1903, but the trials were unsuccessful and hostile press criticism caused the withdrawal of official support. Langley died in 1906. It is claimed that the original machine, "overhauled but not materially changed," flew in 1914, and that "these flights proved conclusively the fact that Prof. Langley developed and built the first man-carrying aeroplane capable of sustained free flight." No reference is made to the recent controversy on this question of priority.

Maj. W. F. Blake gives in *Discovery* for January a full account of the attempt to fly round the world made by Capt. N. Macmillan, Mr. G. Malins, and himself. Beginning their journey on May 24, 1922, his party crossed to Marseilles, thence *via* Athens, Aboukir, Bagdad, Bandar Abbas, Quetta, Lahore, Agra, Cawnpore, reaching Calcutta on August 12. The passage over India was impeded by an unusually heavy monsoon. At Agra, Maj. Blake was struck down by appendicitis, and the other two members of the party on route to Rangoon were forced to descend in the Bay of Bengal, where they were fortunately rescued by Lieut.-Commander Canning, who had been sent from Chittagong to search for them. Maj. Blake, with the experience gained from their adventure, hopes to make a further attempt in 1923.

THE inaugural meeting of the Far Eastern Association of Tropical Medicine was held in Manila in 1908; it was followed in 1910 by the first congress at the same place. Subsequent meetings were held in Hong-kong, 1912, and Saigon, 1913. The fourth congress was held at Weltevreden, Java, in August 1921, and a proposal made on behalf of the Governments of the Straits Settlements and Federated Malay States, that the next congress of the association, in 1923, be held in Malaya, was accepted. Dr. A. E. Horn was chosen president for the forthcoming session, Drs. A. L. Hoops and R. Dowden were elected vice-presidents for the Straits Settlements and Federated Malay States respectively, and Dr. J. W. Scharff as honorary secretary for Malaya. The association, which is open to all recognised medical men, exists to promote the science and art of tropical medicine in the Far East. To this end, it provides opportunities for intercourse among medical men and endeavours to assist in the enlightenment of public opinion on problems of hygiene and particularly of the prevention of disease among the natives. The forthcoming meeting will be held on September 3-17, 1923. The first week of this period will be devoted to scientific discussions, and the following week to excursions to places of medical and sanitary interest throughout Malaya. The Governments of the Straits Settlements and Federated Malay States, recognising the important functions of this association, are contributing a considerable sum towards the expenses.

THE report of the eleventh ordinary meeting of the International Meteorological Committee, held in London, 1921, has recently been published by the Meteorological Office of the Air Ministry. It contains details of the several meetings of the committee and of the commissions for weather telegraphy, marine meteorology, aerial navigation, *réseau mondial*, and polar meteorology. A general account of the work of the International Meteorological Committee has already been published in NATURE (October 6, 1921, p. 194) shortly after the close of the eleventh ordinary meeting held in London in September 1921. The present report occupies 128 pages, more than one half of which consists of appendices giving detailed information of the several commissions held for reporting to the general meeting. Among the details of interest may be mentioned the recommendation that the meteorological stations in high latitudes, commenced in connexion with Amundsen's polar expedition, be continued during 1921 to 1925, and if possible permanently. Other points discussed are the unification of upper air data so that it might be possible to publish, within a few hours of the observations, a chart of upper air observations for the whole of Europe; the study of clouds from the point of view of aviation and the general application of meteorology to aerial navigation; and an endeavour to systematise the adoption of the "kilometre per hour" as the unit of wind velocity by all countries both for land and air. An effort was also made to standardise instruments for registering sunshine.

THE annual report of the Raffles Museum and Library, Singapore, for 1921 shows that, under the energetic direction of Major J. C. Moulton, these institutions make good progress. The number of outside helpers in Singapore and other parts of the world on whose services the museum can draw is a good sign. The formation of a Singapore Natural History Society, with headquarters at the museum, is recorded. Out of 240,000 visitors of various nationalities, 165,000 were Chinese.

MR. BAILEY WILLIS, in a popular paper on "The Geology of the Colorado River Basin with reference to Engineering Problems" (*Science*, August 18, 1922), discusses the boulder-bed in the floor of the Colorado cañon, and the difficulties of building a concrete dam on such a foundation. Work can be carried on between flood-times only, and hence it has been boldly suggested that, since the floods can shift the boulders, more boulders shall be quarried out of the jointed granite and given as playthings to the floods. The river is to be encouraged to construct its own dam to the satisfaction of the engineers who seek to utilise its power.

A WELCOME second edition has made its appearance of the admirable "Guide to the Elephants (Recent and Fossil) exhibited in the Department of Geology and Palæontology in the British Museum (Natural History)." As before, its preparation is the work of Dr. C. W. Andrews, whose name is sufficient guarantee of its excellence. It is slightly increased, as compared with the first edition, by additions to the text, chiefly in the opening paragraphs, and by a new figure. There are also numerous minor emendations, while useful sub-headings have been inserted. Economy has been appeased by issuing the pamphlet in paper covers instead of paper boards.

WE have received a copy of the third volume of Messrs. Baird and Tatlock's Standard Catalogue of Scientific Apparatus. This covers the more specialised apparatus useful in the biological sciences—anatomy, botany, zoology, pathology, agriculture, etc.—though physiology and biochemistry are dealt with in volume 2. The abundant illustrations make it a convenient and useful guide to most of the apparatus which is available, and in turning over the pages a scientific worker may get useful hints towards solving special problems of technique familiar in some department other than his own. Such catalogues do something at any rate towards bringing the different branches of biological inquiry together as well as in facilitating the daily work of the laboratory.

Our Astronomical Column.

NEW OBSERVATIONS OF JUPITER.—Mr. W. F. Denning informs us that Mr. Frank Sargent, of the University Observatory, Durham, observed Jupiter on the morning of December 24, and saw the hollow in which the great red spot is situated central at 19h. 13m. G.M.T., which corresponds to a longitude of 239°·6. Mr. Sargent considered this hollow in the great southern belt decidedly more shallow than formerly. The great red spot appeared to be shorter than at the last opposition, its length being estimated as only 22 degrees.

Following closely behind was the preceding end of the south tropical disturbance which made its transit at 20h. G.M.T. in longitude 268°. The rotation periods of these two objects during the last six months were:

Red Spot Hollow = 9h. 55m. 38s·1.
S. Tropical Disturbance = 9h. 55m. 20s·8.

These periods correspond very nearly with those derived during the earlier part of the year 1922.

BAADE'S COMET.—This comet was observed by Dr. W. H. Steavenson on December 20 and 22. He describes it as follows: "Magnitude 9 to 10, small, compact; diameter about 1′; best defined in position angle 165°, rather diffuse towards 345°; there was central condensation, but no well-defined nucleus."

The brightness is only falling off slowly, and the comet is still within reach of moderate instruments. The following ephemeris, by Mr. Johannsen, of Copenhagen, is very accurate. It is for Greenwich midnight:

	R.A. h.	m.	s.	N. Decl.
Jan. 5.	22	55	22	19° 16′
,, 9.	23	4	30	18 46
,, 13.	23	13	30	18 18
,, 17.	23	22	22	17 54
,, 21.	23	31	0	17 31
,, 25.	23	39	43	17 11

The comet is crossing the lower portion of the square of Pegasus. It is desirable that observations should be continued as long as possible, in order to detect any deviation from parabolic motion.

BRITISH ASTRONOMICAL ASSOCIATION HANDBOOK FOR 1923.—Two years ago, when the well-known "Companion to the Observatory" was discontinued, the Council of the British Astronomical Association decided to bring out the Handbook to take its place (London: Eyre and Spottiswoode, Ltd. Price 2s. to non-members.) Its aim is to supplement, not to supersede the Nautical Almanac, from which little is reprinted except the physical ephemerides. The periods of visibility of the planets are shown graphically; details of important occultations, including four of Aldebaran, are given for 12 stations. Ephemerides are given for Vesta, Eros, and D'Arrest's Comet; it is hoped to extend this section further in future. The large-scale diagrams of the small stars near Uranus and Neptune will be useful for observers of these planets. Notes are included on telescopic objects, lists of tests, ephemerides of variables, and in particular the dates of maxima of 27 stars that attain naked-eye visibility. There are also definitions and an extended list of astronomical constants and elements, which will be slightly varied from year to year. There are thus few observers who will not find the book useful in their domes.

ATMOSPHERIC DISPERSION IN PARALLAX WORK.—One of the factors in the great improvement that has been effected in the photographic determination of stellar parallax has been the recognition that work must be limited to the neighbourhood of the meridian, where the effect of atmospheric dispersion is small. Messrs W. M. H. Greaves and C. Davidson have investigated the resulting correction to the parallax for stars of extreme spectral type in a paper read at R.A.S. November meeting. At 20 minutes of time from the meridian the correction for type B_0 is $-0''\cdot009$, and for type M $+0''\cdot005$. These are quantities that cannot be neglected nowadays, so the necessity is emphasised for working still closer to the meridian where possible.

The same difficulty is present in obtaining the solar parallax from photographs of Eros or other small planets, especially since the diurnal method necessarily involves considerable hour angles. The error can be diminished by using a visual refractor with a light filter, if the object is bright enough to permit of this.

INTERFEROMETER MEASURES OF DOUBLE STARS.—The *Astrophysical Journal* for July has a paper by Mr. Paul W. Merrill on this subject. Mr. Merrill continued the observations of Capella with the 100-in. telescope at Mt. Wilson, and gives the following orbit from his own and Anderson's measures: Period 104·022 days, $a = 0''\cdot0536$, distance 126,630,000 km., parallax $= 0''\cdot0632$, masses 4·2 and 3·3 in terms of sun. He finds that the Greenwich measures in 1900 (on which considerable doubt has been cast) are fairly well represented on the supposition of a motion of the node of 0°·9 per annum; this motion is suggested by the interferometer measures themselves.

The duplicity of κ Ursæ Majoris was independently detected with the interferometer. The magnitude difference is much greater than in Capella, but does not exceed half a magnitude. When Aitken discovered its duplicity in 1907-8, the position-angle and distance were 283°·2, $0''\cdot21$; they are now 251°·3, $0''\cdot08$.

ν^2 Bootis was also examined, but the results were more doubtful; the method is obviously a very powerful one in cases where the magnitudes are not too unequal.

SOLAR PROMINENCE ACTIVITY.—Every half-year the Kodaikanal Observatory, India, issues a bulletin giving a summary of prominence observations during that period. The data for the first half of the present year in Bulletin No. lxx. have just been received. The mean daily areas and daily numbers of the prominences are few, as was to be expected from the cyclical nature of the phenomena, the respective figures being 3·17 (square minutes) and 11·05. Their distribution in latitude shows maxima in the belt 45°-50° in both hemispheres, and is very similar to that for the previous half-year; this indicates that a new cycle of activity has begun in the higher zones of prominences. The statistics give further the distribution of prominences east and west of the sun's axis, the activity of the metallic prominences, particulars of the displacements of lines observed in the spectra of the chromosphere and prominences, reversals and displacements of Hα and D_3, and finally, areas and numbers of prominences projected on the disc as absorption markings. These valuable data are of great importance because they provide a complete record of the activity of the sun from a prominence point of view on a homogeneous system.

Research Items.

SUICIDE RATES.—The relation of suicide to climatic and racial factors, and to industrialism, occupation, urban conditions, age, and sex, etc., is the subject of an extensive statistical analysis by Dr. J. R. Miner (*American Journal of Hygiene*, Monographic Series, No. 2). It has long been recognised that the suicide rate is higher among the Nordic race than among Alpine or Mediterranean peoples. Mixed peoples usually have a higher rate than either of the pure races to which they belong. Foreigners in New York show a higher suicide rate than in the countries from which they came. The lowest rate is found in Ireland and the highest in Saxony, while the rate varies in different parts of France according to the racial composition of the population. Among Asiatic peoples, the Japanese and Chinese rates are high, while in India it is low (4·8 per 100,000). India appears to be the only country where female suicides exceed the male. The general trend of suicide rates has been upward during the last century, but the higher rates tend to become stabilised. A sharp decline took place during the war. Germany, France, Denmark and Sweden have high rates, Britain, Norway and the Netherlands low rates, as well as southern and eastern Europe. In the United States the rates are lowest in the south and highest in the west. The fundamental causes of these differences are found to be probably in (1) differences in the strength of the group spirit, (2) adverse economic conditions, (3) racial factors, (4) general health of the population.

REPRODUCTION IN THE LEODICIDÆ.—Prof. A. L. Treadwell's memoir on the Leodicidæ (Eunicidæ) of the West Indian Region (Dept. Marine Biol. Carnegie Instn., Washington, 131 pp., 9 pls., 467 text figs., 1921) gives a full systematic account and records in the text and in the coloured plates the character of the living coloration. Included in this family is *Leodice* (*Eunice*) *fucata*, which lives in crevices of the coral rocks, protruding the anterior end for feeding but not exposing the remainder of the body except at the breeding season. On the approach of the breeding season the body becomes much distended with eggs or with sperms and swarming occurs usually in coincidence with the last quarter of the June-July moon. During the night the worms protrude their posterior ends from the rocks and break them off at the junction between the sexual and non-sexual portion. The sexual portion swims to the surface and is found in large numbers on the surface at daybreak. Just at sunrise the thin body-wall bursts, the eggs and sperms are liberated, and fertilisation of the eggs occurs. Prof. Treadwell showed in 1914 that there is a measurable increase in the output of carbon dioxide by the egg as it approaches maturity, and he suggests that increased elimination of waste products into the body cavity of the worm may act as a stimulus to egg-laying.

DIGESTION OF WOOD BY THE SHIPWORM.—Dr. P. Bartsch's monograph of the American Shipworms (Bull. 122, U.S. Nat. Mus., 1922, 51 pp., 37 pls.) is restricted to the systematic aspect. He recognises in the family Teredidæ three genera—Bankia, divided into four sub-genera, with eight species; Bactronophorus, not yet reported in American waters; and Teredo, divided into seven sub-genera, with twenty-one species. Systematic descriptions of and keys to the species are given. Dr. Bartsch remarks that although the shipworm takes wood resulting from its boring operations into its alimentary canal, it is questionable whether the secretions of the digestive glands are capable of producing from the wood any soluble carbohydrate. Harington (*Biochem. Journ.* xv., 1921, pp. 736-741) investigated this point more than a year ago and, though he was not able to reach a definite conclusion, the balance of evidence was in favour of the view that Teredo has in its liver an enzyme capable of producing glucose from some constituent of wood, and hence it may be supposed that the wood is to some extent made use of as a source of nourishment.

AMERICAN MYCOLOGY.—The first part of volume 9 of the Annals of the Missouri Botanical Garden (February 1922) is completely filled with a revision by Prof. E. A. Burt of the North American species of Clavaria. This study will be of great value to American students of this group of fungi, and British mycologists will note with satisfaction that full use is made of the valuable study of the British species by Cotton and Wakefield in the Transactions of the British Mycological Society (1919). The author's discussion shows that plenty of work remains to be done by American mycologists, but probably this work with its full reference to American type specimens will provide the necessary stimulus as well as the basis from which to start. The illustrations, photographs of dried herbarium specimens, seem scarcely suitable for a work of this systematic character. In some cases, recognition may be facilitated by the photograph, in others it may well be misleading to unexperienced mycologists. Figures 90, 91, 92, and 94 might very well have been obtained from a single gathering of any one of the four species illustrated.

WET BULB TEMPERATURES AND THERMODYNAMICS.—In the memoirs of the Indian Meteorological Department, vol. xxiii. part 1, Dr. C. W. B. Normand, Imperial Meteorologist, discusses wet bulb temperatures and the thermodynamics of the air. In India in recent years the daily values and the monthly means of wet bulb temperatures have been published, since medical officers pay more attention to the wet than to the dry bulb readings, especially as to conditions liable to cause heat strokes. The aim of the paper is to create further interest in the actual wet bulb temperatures. Mathematical considerations are freely introduced, and the discussion opens up the subject to wider considerations. At the fortnightly meeting held at the Meteorological Office on October 30, the paper by Dr. Normand was taken for discussion, and the subject was opened by the author, who is now in England. A summary of the discussion at the Meteorological Office is given in the *Meteorological Magazine* for November. It was brought out that the term "wet bulb temperature" in the paper is ambiguous, and it was suggested that it seems better to use the term "adiabatic saturation temperature."

METEOROLOGY IN INDIA.—A report on the administration of the Meteorological Department of the Government of India in 1921–22 has just been received. It is drawn up by Dr. Gilbert T. Walker, Director-General of Observatories to the Indian Government. After special investigation Stevenson's thermometer screens, commonly used in Great Britain, are to replace the large open-sided shade hitherto used in India for the exposure of thermometers. This will bring India into line with our home observations, and will effect a very great saving of expense when new screens are required. The English screen is only about one-sixteenth of the price of the Indian screen hitherto used. Much valuable data on the upper wind currents have been recently published and other upper air data are ready for publication. Considerable demand is being made for upper air results over India and the report regrets the inability to do all that is required for want of funds. In the British Isles the staff of workers has been immensely increased and without doubt considerable increase of the staff in India will have to be faced, although it will mean added expense. A graph showing the growth in activity and cost for the last 15 years is given at the end of the report. For want of funds much useful work has been discontinued. The stations over India from which detailed observations are received now number 281, and these have to be supplied with instruments and inspected periodically. Observations are secured from vessels by wireless, as well as from the ordinary logs, over the neighbouring seas. Seismological observations are recorded at several stations and the data are supplied to the British Association. For rainfall over India, there are now 2928 stations from which observations are received.

THE NEW FLIGHT COMPASS.—The United States Air Service has set itself the task of putting the navigation of the air on as trustworthy a basis as that of water, and as part of its programme has asked the Bureau of Standards to investigate the possibilities of the earth inductor type of compass. As a result, a form of instrument has been devised which has proved more satisfactory than any previously in use in the Air Service. A memoir describing the instrument was presented in 1921 to the American Philosophical Society by Messrs. P. R. Heyl and L. J. Briggs, and was awarded the Magellanic premium. It is now reproduced in part 1 of volume 41 of the Proceedings of the Society. An armature driven about a vertical axis by a cup propeller has four carbon brushes set at right angles to each other in contact with its commutator, and capable of being set so that when the aeroplane is flying in a fixed direction, one pair of brushes gives a maximum and the other pair zero electromotive force. The two pairs of brushes are connected to four equally spaced points of a closed electric circuit and a pointer galvanometer connected to two points opposite each other on the circuit. The diameter for which the galvanometer gives zero deflection is determined by the course of the aeroplane.

BURNING HEAVY FUEL-OIL.—Some of the technical difficulties encountered in burning heavy fuel-oil in Diesel engines and other types of heavy-oil engines were discussed by Mr. Harold Moore in a paper read by him at the North-East Coast Institution of Engineers and Shipbuilders, Newcastle, early in December. Ignition trouble, difficulties in burning oil after ignition has taken place, and the problems raised by the presence of small quantities of impurities, were the main factors dealt with as affecting the utilisation of heavy fuel. With regard to ignition trouble, a great deal depends on the range of ignition temperatures possible with varying types of oil-fuel; in Diesel and cold-starting engines, ignition takes place when the heat of compression exceeds the spontaneous ignition temperature of the oil, and it is customary to adjust the compression so as to ensure regular ignition of whatever class of fuel is burnt. The utilisation of various petroleum and coal-tar oils necessitates repeated adjustments being made, and these, under changing conditions of low and high load running, atmosphere, etc., have to be considered carefully both theoretically and practically. Pilot ignition gears, which to a large extent overcome initial difficulties of firing, are now installed on most Diesel and cold-starting engines. After ignition has taken place, the smooth burning of the oil depends primarily on its complete combustion before the exhaust valve opens, and on the rate of burning and influence of the various substances in the fuel. Such substances include the bituminous bodies present in petroleum, hard and soft asphaltum, waxes, and in the case of coal-tar oils (more often employed on the continent than in this country), naphthalene and anthracine. Finally the effects of water, sand, and iron rust, the commonest impurities in oil-fuel, constitute not unimportant factors to be reckoned with. Such impurities are best removed by the employment of high-speed centrifuges.

MAGNETIC OBSERVATIONS AT BATAVIA.—Volume 40 of the Observations made at the Royal Magnetical and Meteorological Observatory at Batavia contains the observations of the year 1917. The preface, however, brings the history of the observatory down to February 1922. From it we learn of the retirement of the well-known director, Dr. W. van Bemmelen, who has been succeeded by Dr. Braak. In addition to the usual meteorological tables, the publication contains some special results of interest, including the results of a 7-year comparison of ordinary thermometers in the thermometer shed and ventilated Assmann thermometers outside. The differences are substantial. The magnetic results are very complete, two magnetographs being in constant operation. The tables of hourly values refer to three rectangular components of force, the horizontal components being in and perpendicular to the astronomical meridian, which is there nearly coincident with the magnetic. An interesting chart shows the departures of the three rectangular components from their mean yearly values. These departures are calculated for 1 h., 7 h., 13 h., and 19 h. G.M.T. of every day, the value assigned to each hour being a mean from 24 hours centering at that hour. The great predominance of disturbance in the north-south component is effectively shown.

PHOTOGRAPHIC SENSITISERS AND DESENSITISERS.—Prof. Rudolfo Namias describes some of his remarkable experiences with these reagents in "The Process Year-Book," vol. xxv., 1923. He agrees with Dr. Luppo Cramer that pinaflavol, the most recently introduced colour sensitiser, is unique in its property of sensitising for the well-known gap in the greenish-blue, and that it and pinacyanol give a "very high increase of general sensitiveness." He finds that pinacyanol may be used in a solution fifty times diluted as compared with the concentration generally advised (finally equal to one part of solid in five millions) and that the spectrographic tests show that this enormous dilution makes no difference in its effect. He has discovered that desensitisers are more important than they were at first thought to be. By getting rid of the sensitiveness of the plate they avoid the formation of the development fog always produced when development is continued to bring out the weak detail which, however, is generally buried by it. By making this detail available we get a practical increase of sensitiveness, though the advantage is restricted so far as is known, to the use of safranine, and of hydroquinone and alkaline bromide in the developer. The increase of general sensitiveness and the elimination of development fog enable one to use slow plates with their much finer grain, and so, without the practical sacrifice of sensitiveness, to get a considerable gain in resolving power.

The Wegener Hypothesis.

DISCUSSION AT THE BRITISH ASSOCIATION, HULL.

ON Monday, September 11, the meeting room of the Geological Section of the British Association was the theatre of a lively but inconclusive discussion on the Wegener hypothesis of the origin of the continents. This hypothesis, which is a development of the well-established theory of isostasy, regards the continental masses as cakes of light siliceous material floating on a heavier basaltic, fluid or viscid, substratum, which in its turn reaches the surface in a solidified form on the floors of the oceans. The continents, which are thus movable, are supposed in Carboniferous times to have formed a single mass, and to have split up by rift-valley formation and started floating apart in late Cretaceous or early Tertiary times. The mountain ranges fringing the Pacific are supposed to have been produced along those margins of the continents which are or have been, in virtue of their motion, impinging on the hard oceanic crust, the belts of thick sedimentation along the continental shelves localising the folding.

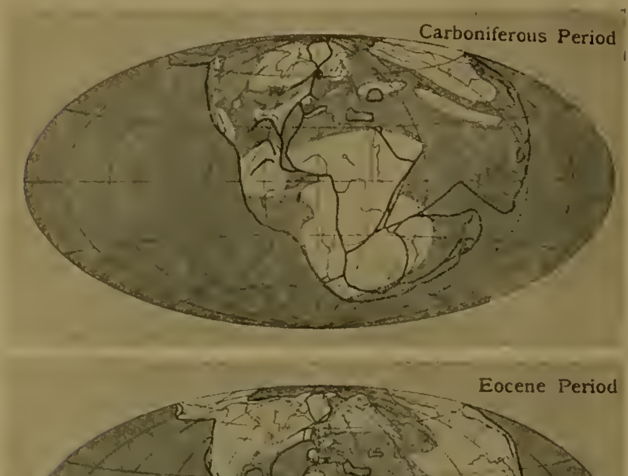

FIG. 1.—The world in the Carboniferous and Eocene periods and Old Quaternary era according to the displacement theory. White denotes land, dots shallow water, cross-hatching deep sea. From *Discovery*, May 1922, p. 116, by the courtesy of the publishers.

The union of the continental masses in former geological times explains many peculiarities in the distribution of life both past and present. It also affords an easy explanation of the hitherto unsolved problem of the Permo-Carboniferous glaciation, by supposing the pole to have been located in South Africa and the other glaciated parts of Gondwanaland to have been grouped around. When a reconstruction of this sort is made it is found that the main Carboniferous coalfields of the world lay, at the time of their formation, within the tropics.

The discussion brought forth a great diversity of opinion regarding the validity of the hypothesis, almost the only point on which there seemed to be any general agreement being an unwillingness to admit that the birth of the North Atlantic could have occurred at so late a date as the Quaternary. Proceedings were opened by the reading of a discourse by Dr. J. W. Evans, who was unfortunately unable to be present. Dr. Evans gave an outline of some of the leading features of the theory and emphasised the well-known similarity of the geological formations on opposite sides of the oceans. He, however, questioned Dr. Wegener's estimates of the thickness of the crust whether continental or oceanic, and considered that the latter, being probably as strong as the continental crust, would inhibit the continental drift. He dealt more particularly with the supposed recent variations of relative longitude and with the precautions which would have to be taken in the case of an attempt to repeat the observations.

Prof. H. H. Turner stated that the only piece of astronomical evidence supporting Wegener's hypothesis, and worthy of serious consideration, was the apparent westerly drift of Greenland. He was inclined to regard the longitude observations made up to the present as so much waste paper, but considered that the magnitude of the discrepancies between the Greenland observations of the years 1870 and 1907, which indicated a westerly drift relatively to Europe of 1200 metres, made a good case for repeating the observations to-day.

Mr. W. B. Wright pointed out that a critical comparison of the geological formations on the two sides of the North Atlantic shows on the whole a very remarkable correspondence, both stratigraphical and palæontological, from the Archæan to the Cretaceous, and in particular brings to light certain facts even more strikingly indicative of a former *rapprochement* between the two continents than any pointed out by Wegener.

The recurrence in America on opposite sides of the old Appalachia of the two facies of the European Cambrian and early Ordovician, which are here separated by the Caledonian chain, is perhaps the most striking, the lithological and faunal characters and the sequence of transgression and recession, different on either side of the chain, being reproduced with remarkable precision. Again, the continental and marine facies of the Devonian are separated in both countries by boundaries which become conterminous on the Wegener reconstruction.

Prof. Coleman, of Toronto, considered that the similarity in the Archæan formations on the two sides of the Atlantic, cited by Mr. Wright, meant very little, as the Archæan was a universal formation. He also raised the question of the meteorological conditions of the supposed compacted continent of Gondwanaland, which he thought must necessarily have been a desert and therefore could not have nourished an ice sheet.

Prof. Sollas confessed himself attracted by the theory but doubtful as to proofs. He was not greatly impressed by arguments based on the similarity of the geological formations on the opposite sides of the oceans, the most remarkable of which was perhaps that cited by Mr. Wright. A certain uniformity is to be expected in rocks derived from the same Archæan base. The explanation on the whole was out of proportion to the points of correspondence cited.

Dr. Harold Jeffreys stated that the rotational force which could be invoked to explain the movements of the continents was very small and quite insufficient to produce the crumpling up of the Pacific ranges. The ocean floors also presented a difficulty, for, being composed of basaltic rock, they would be less radioactive and therefore stronger than the continental crust. The withdrawal of India northward and its gathering up into the Himalayan folds were moreover not easily accounted for.

Prof. Gilligan said that, as the great piles of Palæozoic sediments in Europe and America reached their maximum thickness on the borders of the Atlantic, it seemed necessary to assume the presence of a continent occupying the northern part of the ocean. The time-honoured conception that the earth shows a tendency towards a tetrahedral form was also in conflict with this new hypothesis.

Dr. G. C. Simpson thought the theory was a wonderful one from the meteorological point of view, as it explained the marked changes of climate given by the geological record and in particular the excentric position of the Quaternary ice-sheets with reference to the pole.

Prof. Marshall, of Wanganui, New Zealand, pointed out that the movement of that country was to the east and not to the west. Speaking from personal knowledge of a number of the Pacific Islands and referring to the evidence they afforded as to the composition of the floor of the ocean, he said it was a mistake to suppose that the igneous rocks exposed in these islands were entirely basaltic. Alkaline rocks were also represented, but, so far as he was aware, siliceous rocks of continental type were unknown.

Dr. F. E. Wright spoke briefly, and Prof. Boswell referred to the forthcoming English edition of Dr. Wegener's book as affording an easy means of becoming acquainted with the leading features of the subject.

The president, Prof. Kendall, in closing the discussion said he had many years ago examined the question of a land connexion across the Atlantic, especially in its bearing upon the distribution of fishes and reptiles. The practical identity of the Old Red fish faunas of the Orkneys and N. America seemed to show a very close connexion, and the similarity extends to the Carboniferous. Divergence, especially in the reptiles, is marked in the Trias and probably complete throughout the Jurassic. Unfortunately the reptiles require two barriers, one of land to stop the migration of the marine forms, and one of sea to inhibit that of the land forms. The evidence adduced by Martin Duncan and marshalled by Gregory proved a connexion between Europe and America during the Oligocene. He had long ago found it necessary to abandon a belief in the absolute permanence of ocean-basins.

The discussion as a whole was interesting as bringing out the extreme divergences of opinion produced by viewing the hypothesis from different aspects, astronomical, physical, meteorological, and biological, but it becomes very apparent that the surest test of its validity lies in the domain of geology.

W. B. Wright.

The National Research Council of America.

THE National Research Council of the United States corresponds to the Department of Scientific and Industrial Research in this country. It owes its being, as does our organisation, to the very urgent need, which the war made patent to governments, of an organised and systematic attempt to foster scientific research, to extend its industrial applications and, by co-operation and co-ordination, to do this on a national scale. The sixth annual report of the National Research Council, for the period ending June 30, 1921, shows clearly the extent to which this organisation has been carried in the United States. There are divisions based on political classification, *e.g.* Federal, foreign and States relations; on functional classification, *e.g.* educational relations, research extension and information service; and, finally, on a scientific and technological classification, *e.g.* physical sciences, engineering, chemistry and chemical technology, geology and geography, medical sciences, biology and agriculture, anthropology and psychology.

A popular chemical exhibit "to show the American people what the chemist has done and may do for them," prepared by the Chemical Warfare Service of the United States Army, was held in Washington, and arrangements have been made to install it as a permanent exhibit in the United States National Museum.

The division of educational relations has given special attention to the study of the detection and encouragement of students of superior ability, and is co-operating in this investigation with the division of anthropology and psychology.

Among the projects of the division of research extension may be mentioned the following: An underwriting fund of 200,000 dollars is to be raised for the compilation of critical tables of physical and chemical constants. Measures are afoot for the establishment of a Crop Protection Institute; an Alloys Research Association; a school for tanning to be affiliated to an established university; a Textile Research Institute; and a Horological Institute of America, which will be concerned primarily with the scientific phases of time keeping with special reference to the mechanical devices necessary.

The research information service has for its purpose "to promote scientific and industrial research in this country through the operation of an active exchange for all kinds of scientific and technological knowledge." It prepared for publication Bulletin No. 9, Funds Available in 1920 in the United States of America for the Encouragement of Scientific Research, giving an account of medals, prizes, grants and research scholarships and fellowships amounting in value to approximately 36,000,000 dollars annually. In addition to research in personal records the service has a catalogue of 20,000 chemists and mining engineers, and a file of current investigations.

From the division of engineering a report embodying the results of the investigations on fatigue phenomena of metals will be published shortly. The results indicate that a rise of temperature test may furnish a trustworthy accelerated test for fatigue resistance. It is stated that "this report contains the most valuable and complete information ever published on this subject." We shall await its appearance with much interest.

Owing to the very sudden increase in the destruction of marine piling in San Francisco Bay resulting from the attack of marine borers, which amounted in value to about 15,000,000 dollars in the last year or two, a marine laboratory has been established in San Francisco Bay and the National Research Council has taken measures for undertaking co-ordinated investigations on the problem. The report states: "This is one of the most important problems presented to the National Research Council since its organisation and one of the best illustrations of the important service which can be rendered by a national body of this sort. It is also an excellent illustration of the need for co-operation between the scientific and engineering groups."

The committee on ceramic research has selected the following four subjects to receive early attention: (1) A study of the elements which determine the plastic nature of clay; (2) a critical examination of certain methods used in silicate analysis; (3) a study of American pot clays and their proper compounding for the production of refractories used in the glass industry; (4) a study of the relationship between crazing and the expansion coefficients of bodies and glazes.

Enough has been indicated of the character of this sixth annual report of the National Research Council to convince, perhaps, even the warmest exponent of the theory of science for science's sake and of the inalienable right of the scientific spirit to go whither it will, that there is a vast field of scientific research meet for organised co-operation on national lines. J. W. W.

International Contributions to Mendelism.

THE Dutch journal *Genetica*, under the editorship of Dr. Lotsy and Dr. Sirks, has published an excellent international number as a Mendel Memorial in connexion with the recent centenary celebrations in Brünn and Vienna. In a long and carefully written article, Prof. V. Häcker (Halle) reviews the present state of knowledge of Mendelian inheritance, especially as regards cytological interpretation and other aspects of general interest. Such a cautious and well-informed statement is most valuable at the present time. Dr. E. Fischer (Zürich) describes his large series of experiments in breeding the Silver-washed Fritillary (*Argynnis paphia*) and its dimorphic female, the well-known var. *valesina*. It used to be thought difficult to get such creatures to breed in confinement, but Dr. Fischer, following a technique which he describes, has raised several thousands as the result of various matings. Prof. R. Goldschmidt (Berlin) contributes an analysis, and suggests a factorial scheme which fits the numbers fairly well. There is a dominant *valesina* factor, V, which is not sex-linked, and the combinations VV, *Vv*, *vv* are possible both in males and females. Since, however, the males are all *paphia* alike, their genetic constitution can be decided only by experimental breeding. We are still as far as ever from understanding how it comes to pass that the males are thus uniform, though they may contain even two doses of the element which in a single dose suffices to give the dominant character to the female, a difficulty which has puzzled geneticists very long. There are many parallel examples in butterflies of di- and polymorphic females, though nothing analogous is ever seen in the males. The cytological scheme which so successfully represents the observed facts in colour-blindness and similar examples here apparently fails, and the special interpretations offered by Goldschmidt, though suggestive, are scarcely more than a restatement of the difficulty.

Prof. Ghigi (Bologna) discusses the origin of domesticated poultry, especially fowls and pigeons, in the light of his breeding experiments. He leans to the conclusion, which other evolutionists have also reached, that it is most difficult to suppose, as Darwin did, that the various breeds of fowls are derived simply from *Gallus bankiva*, or the pigeons collectively from the rock-dove. The plausible suggestion is here made that the heavy breeds of fowls, which constitute the main problem, may have come from some partially flightless island form, taken bodily into domestication, since nothing of the sort now survives in a wild state. Some of the pigeons, he thinks, may be derived from crosses with *Columba leuconota*, which when bred with tame pigeons gives, as he found, at least fertile males. The effect of all these appeals to multiple origins, necessary as they now appear to be, is to weaken confidence in the classical deductions as to unlimited possibilities of variation under domestication apart from cross-breeding.

Other interesting papers are those of Prof. J. L. Frateur (Louvain) on compound characters, M. A. Meunissier (Paris) on the 3-podded and other varieties of peas, and Dr. Winge (Copenhagen) on some curious and complex phenomena in Drosophila, which favour the hypothesis already entertained by several biologists that mutation may sometimes be the consequence of a rare cross-over. Dr. Sirks (Wageningen) recounts his experiments with a new subspecies of *Linaria vulgaris*, giving a mixed F_1 generation in crosses with the wild type, an unexpected result which may be variously interpreted. A remarkable experiment is also described by Prof. J. Schaxel (Jena), who succeeded in grafting together limb-buds of the coloured and the white forms of Axolotl, producing limbs compounded of both elements so intimately associated that the name "Chimæra" may be applied to them, on the analogy of Winkler's famous graft-hybrids made between the tomato and *Solanum nigrum*.

This collection of memoirs reaches an unusually high level. All contain material of permanent value.

The Oldebroek Explosion of October 28, 1922.

IN NATURE of November 4, p. 619, a preliminary note appeared on the great explosion at Oldebroek. It is now possible to discuss more fully the results obtained.

About 140 reports were received from observers in the British Isles. Of these, nearly one-third stated that despite careful listening they heard no sound that appeared to be due to the explosion.

When the distribution of the positive and negative reports is studied, the most notable feature is the entire absence of positive reports from the greater part of the Midlands of England. With regard to Europe generally, it appears that the sound was reported so far off as 850 km. to E.S.E., 600 km. to S. and 700 km. to N.W. of Oldebroek, whereas no single trustworthy observation was reported in a zone between the limits of 100 and about 180 or 200 km. radius. Confirmation of the existence of a "Silent Region" was therefore once more obtained. Also, the times which the sound waves took to reach various distances are in most cases longer than they would be for normal propagation through the surface air.

The accuracy of the time standard of the average non-scientific observer is not likely to be high, but when the British observations are classified with reference to apparent velocities of propagation, there appears to be some evidence that these tend to group themselves about points corresponding to velocities of 257, 335, 370, and 508 metres per second. The second group corresponds very closely to propagation through the surface layers of air, due allowance being made for temperature and wind. In view of the uncertainty as to the accuracy of the observed times, it is doubtful whether the observations of the third group are to be regarded as truly distinct from those of the second, but it is just possible that this velocity is to be explained by the assistance of a strong north-easterly wind, and, though there is no actual measurement, it is not improbable that such a wind may have existed somewhere about the three- or four-kilometre level. At a height of one kilometre the mean wind over south-east England was north-easterly 15 m/s, and at a height of two kilometres E.N.E. about the same velocity. A *ballon sonde* reaching 9 km. indicated a resultant drift for the whole trajectory from about N.N.W., and a cirrus cloud observation obtained in Holland indicated an apparent velocity equivalent to 33 m/s from W.N.W. at a height of 10 km.

Of special interest are the first and fourth groups with velocities centring at 257 and 508 m/s respectively. Five of the seven observations indicating the latter velocity were made at very considerable distances from Oldebroek, namely at Newcastle, Bolton-le-Moors, Skipton-in-Craven, Northallerton, and Guernsey. Prof. E. van Everdingen is of opinion that such observations and the proven existence of the "Silent Region" afford very strong evidence of the co-operation of the hydrogen atmosphere. The view that the appearance of silent regions is to be ascribed to a change in the constitution of the atmosphere at great heights was put forward by Von dem Borne in 1910. Making certain assumptions as to the constitution at great heights, he calculated that the shortest possible distance at which sound rays, curved back by this high atmosphere could reach the surface was 114 km., the ray becoming horizontal at a height of 75 km. Actually no case of so short a distance has yet been found. In 1915 van Everdingen, taking Wegener's hypothesis as to the occurrence of geocoronium in the atmosphere and his percentage values as to constitution, showed that it gave no better a result. On testing various hypotheses, the best results appeared to indicate a percentage of hydrogen at surface level of 0·0001.

In addition to the observations discussed above collectively, certain special observations were made in this country. The Acoustical Research Section of the Signals Experimental Establishment contributed most valuable records obtained by means of hot wire microphones at Woolwich and at Biggin Hill, Kent. These were described and discussed in detail by Major W. S. Tucker in a paper to the Royal Society of Arts on November 29. In the case of the Biggin Hill record he attributes the first effect (indicating a velocity of nearly four times that of sound in air) to propagation through the water and the ground.

At Eskdalemuir Observatory at 17 h. 29 m. G.M.T. a small upward movement of about one-thirtieth of a millibar on the microbarograph record was followed about 13 minutes later by an approximately equal one in the opposite direction. On the traces of the other instruments, including the seismographs, no evidence of an explosion effect is to be found. Mr. J. J. Shaw (West Bromwich) could also find no evidence on his seismograms, but stated that at the critical time many thousands of pedestrians and heavy vehicular traffic (the returning crowd from a football match) were passing his house.

The collected observations of the various European countries are now being investigated by Prof. van Everdingen of the Dutch Meteorological Service.

University and Educational Intelligence.

Among University Extension agencies the Summer School plays an increasingly important part. This year eleven universities and university colleges in Great Britain were responsible for at least fifteen summer schools, not counting those organised by joint committees for tutorial classes in connexion with the Workers' Educational Association. In the United States, summer courses are provided in numbers and on a scale far in excess of anything that has been attempted elsewhere. The Bureau of Education, Washington, has published a Bulletin on the subject (1922, No. 31) in which are shown the student enrolments in last year's summer schools of the twenty-seven universities and colleges which sent representatives to the meeting of the Association of Summer School Directors. The largest were: Columbia 11,809, Chicago 6458, California 6176, Wisconsin 4547. Fourteen other institutions had enrolments exceeding 1000 each. On the other hand, many of the best known, including Yale, Princeton, Vassar, and Brown, do not receive summer students: Yale experimented with the system for three years and then gave it up. Some of the most conservative colleges, while not undertaking summer schools of the ordinary type, have opened their doors in the summer for conferences and for special classes designed to establish contact with industrial workers. Many hesitate, as do universities in this country, to increase their commitments in this direction for fear of financial difficulties. State universities regard the matter in a different light, and find that this and other forms of extension work help to justify in the eyes of the taxpayers their large demands on the public purse. In general the courses are devoted principally to the liberal arts and sciences and to education, but some schools of law, medicine and dentistry offer courses which count for their degrees, and in a few institutions engineering and architecture courses are provided.

From the Royal Technical College, Glasgow, we have received a copy of their annual report on the work of the session 1921–22. Owing to the cessation of special classes held at the request of the Ministry of Labour under their "Interrupted Apprenticeships" Scheme, the number of students was slightly lower than in 1920–21, but compared with 1913–14 the year's enrolment shows an increase of 150 per cent. The research work carried on in the college is extending rapidly in volume and importance, especially in chemistry, metallurgy, and engineering. Much of it is undertaken at the instance of industrial research associations by the associations' own workers under the supervision and guidance of the professors concerned. The course for the diploma in chemistry, recently extended from three to four years, includes in its final year three months devoted to experimental inquiry, on which a thesis is required to be written. This plan has been an unqualified success, the report says, from an educational point of view, and some of the theses presented last year were of such intrinsic value as to warrant publication. In more than a hundred centres in the surrounding counties affiliated continuation classes in science and technology were conducted by education authorities: nearly all evening students entering the college, except those from a considerable distance, present qualifications gained in such affiliated classes. The school of pharmacy is now thoroughly established, and several students are preparing for the B.Sc. degree in pharmacy of the University of Glasgow.

RECENT developments in the Swedish national school system are described in an article by Prof. Hänninger of the Landskrona Training College in the November number of *School Life*—an official journal of the United States Bureau of Education. In 1919 the Government prescribed for use in the folk-schools a new instruction plan, the outstanding feature of which is "home and community study," involving lessons based on direct observation of the environment of home and school and linking the observed facts with geography, nature-study, history, drawing, and sloyd. About the same time were established two-year continuation schools with a total of 360 hours of instruction, directed in the main on practical lines, and including citizenship and the mother-tongue, and either a craft or natural history, sloyd, and horticulture. These schools are to be obligatory after 1924. Apprentice schools with two-year curricula, for which the continuation schools serve as a preparation, may be made compulsory at the option of the local community. In the apprentice schools the instruction comprises 6 to 12 hours per week during 8 or 9 months of the year. Beyond it is an optional crafts school with a one-year course. In a report just issued by a Grand School Commission proposals are made for substituting for the existing dual system (folk-school and *realskola*) a common foundation school to be attended by children of all classes for six years, leading to a middle school with a four-year course, to be followed by a three-year "gymnasium."

HIGHWAY Engineering and Highway Transport Education problems were discussed at a conference held at Washington on October 26-28, under the auspices of the United States Highway Education Board. Between 1910 and 1922 the number of motor vehicles increased 2000 per cent. (to ten and a half millions), while the increase in funds for road building was only 400 per cent. Neither highway construction nor highway transport education have kept pace with the stupendous increase in automobile traffic. The trend in the colleges at present is towards a system whereby certain fundamental courses covering about 5 semester hours in highway engineering are required of all civil engineering students, while an equal amount of optional supplementary highway instruction in the subject is offered for intending specialists.

IT is announced in the *British Medical Journal* that the University of Paris has received two gifts of 100,000 francs each from Madame Edouard Nathan. The first of these is to be applied to the improvement of the scientific laboratories of the University, and to the promotion of research work. The second is to be set apart for the purpose of making loans to impecunious students of the University to enable them to continue their studies.

THE *Chemiker Zeitung* of October 28 reports that Prof. Pfeiffer, of the Technische Hochschule, Karlsruhe, has been appointed Director of the "Josefine und Eduard von Portheim-Stiftung für Wissenschaft und Kunst" in Heidelberg, and will direct the Chemical Research Institute of this Fund.

Societies and Academies.

LONDON.

Physical Society, December 8.—Dr. Alexander Russell, in the chair.—G. **Shearer**: The relation between molecular and crystal symmetry as shown by X-ray crystal analysis. By X-ray analysis the number of molecules associated with the unit cell is determined. The symmetry number for each of the 32 crystal classes is shown to mean the minimum number of asymmetric molecules necessary in the unit cell to satisfy the symmetry conditions. The symmetry number is the actual number of molecules in the cell when the molecule is asymmetric; if the molecule possesses symmetry, this symmetry appears also in the crystal, and the number of molecules in the unit cell is obtained by dividing the symmetry number of the crystal by the symmetry number of the molecule.—E. A. **Owen** and G. D. **Preston**: Modification of the powder method of determining the structure of metal crystals. Plates of aluminium, iron, copper, lead, and magnesium have been examined by means of the Bragg X-ray spectrometer, employing radiation direct from a molybdenum anti-cathode. The maxima in the spectra are sufficiently intense to measure with accuracy, and the crystalline structure of the materials examined are readily determined.—A. B. **Wood**: The cathode ray oscillograph. The instrument is of the low-voltage type, in which a hot cathode is employed as a source of the electron current. This low-voltage type of oscillograph is much more sensitive than the high-voltage cold-cathode type of M. Dufour. There are various methods of focussing the cathode-ray stream, and it has been proposed to have an external (*i.e.* outside the vacuum) photographic film. Ordinary gelatin-coated roll films or plates are unsuitable, owing to the marked absorption of the cathode-rays by the gelatin. The best results have been obtained with Schumann plates containing calcium tungstate. This material phosphoresces with a light rich in ultra-violet, and consequently the secondary luminous effect on the Schumann plate is very great. Mechanical, electrostatic, and electromagnetic methods are described for generating a time-axis on the records.—R. **Webb**: A low-voltage cathode ray oscillograph. The instrument is designed to work at 300 volts. The cathode consists of a hot platinum filament coated with certain oxides, and formed into a circle coaxial with the path of the rays. It is protected from bombardment by positive rays, which would disintegrate it, by a screen in which is cut a circular hole slightly less in diameter than the filament. It has a life of about 200 hours. The anode is a platinum tube through which the rays pass. The deflecting fields are electrostatic, and are provided by two pairs of plates at right angles. The bulb is in the form of a conical flask, the cathode being at the narrow end so that the rays impinge on the flat bottom, which is coated inside with fluorescent matter. The luminous trace of the rays can be seen from outside through the bottom of the flask.

Royal Meteorological Society, December 20.—Dr. C. Chree, president, in the chair.—C. J. P. **Cave** and R. A. Watson **Watt**: The study of radiotelegraphic atmospherics in relation to meteorology. Results obtained in 1915, at the Meteorological Office Radio Station, Aldershot. Radiotelegraphic direction finding on atmospherics was introduced as a means of locating thunderstorms, and successful observations were made, with the co-operation of the Admiralty coast stations, on storms as near as five miles to an observing station, and on other storms 1000 miles distant. The first thunderstorm thus located, and confirmed by subsequent meteorological reports, occurred in the south of Ireland on July 24, 1916, at a distance of 280 miles from the most distant station participating in its detection. A storm was traced across the Bay of Biscay and Southern France, a thunderstorm at Venice was located by two stations a thousand miles away, and a storm five miles from Aldershot was followed by the direction finder there, the bearings given being in complete agreement with the bearing of the audible thunder and the visible storm.—C. J. P. **Cave**: Winter thunderstorms in the British Islands. During the first three months of the years 1916, 1917, 1918, and 1920, the number of storms occurring in tne winter months was very remarkable, there having been storms somewhere in the region on more than 40 per cent. of the days. Some of the storms were very widespread. They seem to have been connected with the occurrence of masses of air at widely different temperatures in close proximity. Thunderstorms are caused, it is suggested, (1) by the heating of the lower layers of the atmosphere, (2) by the cooling of the upper layers, (3) by a warm current of air rising over a cold one, (4) by cold air undercutting warm air.—D. E. **Row**: Forecasting sky-types. The type of pressure distribution as shown by a map or suggested by the "Further outlook" of the Meteorological Office, and the part of it which is likely to affect the locality concerned, is used, and local indications are considered. For example: Cirrus types followed by cumulus forms are to be expected during the passages of depressions, or even where overlapping occurs between an anticyclone and a depression. Indefinite areas of low or medium pressure often give very composite skies, thus yielding striking cloudscapes in which a large variety of cloud types is featured simultaneously.

DUBLIN.

Royal Irish Academy, December 11.—Prof. Sydney Young, president, in the chair.—J. J. **Nolan**: Ionic mobilities in air and hydrogen. The composite nature of ordinary ionisation in air is demonstrated by a third method. The ionisation in hydrogen is examined by the Rutherford-Franck method. The results obtained are similar to those already found for air and are, in general, confirmatory of the work of Haines. The ionisation is more complex than Haines's work would indicate, and a high degree of purity or drying is not necessary to bring out this feature. Criticisms by Blackwood are considered.

PARIS.

Academy of Sciences, December 11.—M. Émile Bertin in the chair.—Pierre **Termier**: The structure of the eastern Alps: relations of the Dinarides and the Alps.—A. **Rateau**: Pressures and specific gravities of air in a normal atmosphere.—M. H. Vincent was elected a member of the section of medicine and surgery in the place of the late M. A. Laveran.—Gaston **Julia**: Rational substitutions with two variables.—Maurice **Lecat**: The development of determinants as a function of determinants with axial empty spaces.—Lucien **Mouren**: New nomograms with aligned points applicable, in particular, to problems of navigation and their mechanical realisation.—M. Amoroso **Costa**: Concerning a note of M. Borel.—Mlle. O. **Jasse**: The Comas Sola planet of November 26, 1922: its identity with (629) Bernardina.—J. **Guillaume**: Observations of the sun, made at the Lyons Observatory during the second quarter of 1922. Observations were possible on 80 days in this quarter; the results are summarised in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—L. **Décombe**: The direct calculation of the secular perihelic displacement of the planets on the hypothesis that the gravitation is of electrical origin. Application to the planet Mercury.—F. **Michaud**: The rigidity of jelly. The influence of a dissolved crystalloid. An application of a method described in an earlier note, capable of measuring a modulus of rigidity one-hundredth of that measured by Schwedoff. The effects of adding acids, bases, mineral salts, and organic substances have been studied.—A. **Dauvillier** and Louis **de Broglie**: Remarks on the work of M. E. Hjalmar concerning the M series of the elements. The measurements recently published by Hjalmar confirm the theory of the structure of the Röntgen spectra of the elements developed by the authors.—G. **Durante**: An apparatus for microphotography. Simplicity, transportability, and low cost are the advantages claimed for the apparatus described.—Georges **Déjardin**: The ionisation of mercury vapour in the presence of argon. The phenomena described in detail can be best explained by assuming that for electrons traversing an atmosphere of argon there exists a first critical velocity corresponding to about 11·3 volts, and that the resonance radiation emitted by the gas under these conditions ionises the vapour of mercury. This ionisation is not accompanied by any notable modification of the mercury spectrum.—G. **Denigès**: The rapid estimation of magnesium in a single drop of sea-water. The method is based on Schlagdenhaufen's reaction, the colour produced by the interaction of magnesium salts and potassium hypoiodite.—L. J. **Simon** and A. J. A. **Guillaumin**: Methylisopyromucic acid and a method of diagnosis of the acids of the sugar group. The dehydration of the lactone of rhamnonic acid gave methylisopyromucic acid, a description of which is given.—Marcel **Delépine**: The dipyridine iridium tetrachlorides. Configurations of the iridio-dipyridinotetrachlorides.—M. **Picon**: The action of sodammonium on aniline and its homologues. Sodammonium (in liquid ammonia) and aniline react slowly at the ordinary temperature giving hydrogen, sodium amide, and the aniline derivative $C_6H_5 . NHNa$. The last named reacts violently with ethyl bromide, giving ethylaniline. Other aryl amines behave similarly.—E. E. **Blaise**: Syntheses by means of mixed organozinc derivatives: propylglyoxal.—Léon **Moret**: The existence of the upper Cretaceous (facies "Red layers") in the Autochthone in the neighbourhood of Thônes (Haute-Savoie).—F. **Roman** and J. Royo **Gomez**: The existence of Lutecian mammals in the Douro basin (Spain).—V. **Van Straelen**: The decapod crustaceans of the Portland beds of Cerin-Marchampt.—Henri **Coupin**: The origin of the siliceous carapace of diatoms.—A. **de Puymaly**: The adaptation to aerial life of *Zygnema peliosporum*.—E. **Chauvin**: The toxicity of *Volvaria gloiocephala*. This fungus, commonly considered as poisonous, when gathered near Algiers was shown by A. Gautier to be edible without inconvenience. The author has gathered the same fungus in France (Fontainebleau) and eaten it without ill-effects.—V. **Vincent**: The measurement of the acidity of soils by alkaline liquids.—L. **Fage** and R. **Legendre**: Fishing with a submerged source of light as a means of studying the coast fauna.—Mme. Z. **Gruzewska** and M. **Fauré-Frémiet**: The maximum quantities of reserve glycogen in the livers of dogs of different ages.—L. **Garrelon**, D. **Santenoise**, and R. **Thuillant**: The parallelism between the sensibility to the oculocardiac reflex and the sensibility to toxic actions.—Mlle. France **Gueylard** and M. Marcel **Duval**: The comparative toxicity of various acids for fishes (*Gasterosteus aculeatus*). The hydrogen ion concentration is not the sole cause of the rapid death of the fishes in acidified solutions: the nature of the acid has also an important influence.—Aug. **Michel**: Caudal regeneration in *Polygordius neapolitanus*.—H. **Barthélémy**: The maturation *in vitro* and the activation by puncture of the ova of *Rana fusca* at the moment of discharge from the frog.—M. **Charcot**: Preliminary report on the voyages of the *Pourquoi-Pas?* in 1922.—A. **Desgrez** and H. **Bierry**: A mode of action of Vichy waters.

WASHINGTON.

National Academy of Sciences (Proc. Vol. 8, No. 11, November 1922).—J. A. **Marshall**: Bactericidal properties of the products of radium emanation. Old radium emanation tubes which have undergone disintegration in respect of γ-ray content are crushed under Ringer's solution in a sterile mortar. The radioactive solution obtained is conveyed immediately to the infected areas by sterile dressings; in the case of abscesses at the roots of teeth, it is injected through the pulp canal. This treatment gives better results than other antiseptic agents.—H. S. **Washington**: The jades of Middle America. The jades investigated are from a sacred natural well in the ancient Maya city of Chichen Itza, in northern Yucatan. The dominant colours are grey and green. They are jadeite jades of American origin, and differ from Asiatic jadeite in the large amount of diopside in the pyroxene they contain and the presence of much albite. Analyses are given.—Carl **Barus**: On a comparison of the relative sensitiveness of telephones. An interferometer U-gauge is connected by a quill tube to the telephone mouthpiece and a relation is obtained between the fringe movements and the constants of the instrument.—Carl **Barus**: The equilibrium positions of the vacuum gravitation needle in 1921 and 1922. From the curves given, the variations of the position of equilibrium in the lapse of time are of a different order in 1922 from their approximate constancy, in the given scale, in 1921. This may be due to the difference in the vacua obtained. All observations have a period of 24 hours, indicating solar radiation as the origin of the variations.—W. W. **Coblenz**: Further measurements of stellar temperatures and planetary radiation. (See NATURE, December 30, p. 886.) H. A. **Lorentz**: Proof of a theorem due to Heaviside. The theorem in question is: "The whole work done by impressed forces suddenly started exceeds the amount representing the waste by Joule-heating at the final rate (when there is any), supposed to start at once, by twice the excess of the electric over the magnetic energy of the steady field set up."—A. J. **Lotka**: The stability of the normal age distribution. There is an age distribution which, in certain circumstances, perpetuates itself when once set up in a population. An analytical method is used to show that this distribution is stable and that a population spontaneously reverts to it if the age distribution be displaced.

Official Publications Received.

Journal of the Indian Institute of Science. Vol. 5, Part 4: Induction Motors used as Synchronous Machines. By S. V. Ganapati and R. G. Parikh. Pp. 37-46+9 plates. 1.8 rupees. Vol. 5, Part 5: The Relation between the Iodine Values and Refractive Indices of some hardened Vegetable Oils. By J. J. Sudborough, H. E. Watson, and D. Y. Athawale. Part 1. Pp. 47-69+3 plates. 1.8 rupees. (Madras: Indian Institute of Science.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1921-22. Pp. iv+32. (Barbados.) 6*d*.

The British Mycological Society. Transactions. Vol. 8, Parts 1 and 2, December. Pp. 111. (London: Cambridge University Press.) 15*s*. net.

Leeds University. Eighteenth Report, 1921-22. Pp. 190. (Leeds.)

Ministère de l'Instruction publique et des Beaux-Arts. Enquêtes et documents relatif sà l'enseignement supérieur. 117: Rapports sur les observatoires astronomiques de Province. Année 1921. Pp. 127. (Paris: Imprimerie Nationale.)

Diary of Societies.

SATURDAY, JANUARY 6.

ASSOCIATION OF WOMEN SCIENCE TEACHERS (at University College), at 2.30.—Dr. Dorothy Wrinch: Relativity.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Six Steps up the Ladder to the Stars (5). Two Great Streams of Stars (Juvenile Lectures).
GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—G. J. B. Fox: A Visit to Pompeii.

MONDAY, JANUARY 8.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. W. Moss, and others: Discussion on the Protection of Inventions by Letters Patent.
ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Rev. Leslie J. Walker: A New Theory of Matter.
SURVEYORS' INSTITUTION, at 8.—F. W. Hunt: Zoning in the Control of Large Cities.

TUESDAY, JANUARY 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Six Steps up the Ladder to the Stars (6). The Size of a Star. (Juvenile Lectures.)
SOCIETY FOR THE STUDY OF INEBRIETY (at Medical Society of London), at 4.—Dr. H. Campbell and others: Discussion on The Pathology and Treatment of Morphia Addiction.
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Dr. W. R. Ormandy and E. C. Craven: Further Investigations into the Physico-Chemical Significance of Flash-Point Temperatures.
MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—A. Brammall and H. F. Harwood: Dartmoor Granite: (*a*) Rutile, Brookite, and Anatase: Genesis. (*b*) Varieties of Zircon: their significance.—Dr. A. Hutchinson: A Graphical Method of Correcting Specific Gravity Determinations.—Dr. L. J. Spencer, with microscopical determinations by W. Campbell Smith, and chemical analyses by E. D. Mountain: A Davyne-like Mineral and its Pseudomorphs from St. John's Island, Egypt.
INSTITUTION OF CIVIL ENGINEERS, at 6.—H. W. H. Richards: Twelve Years' Operation of Electric Traction on the London, Brighton, and South Coast Railway.
INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—H. Campbell: Gas Engines, and Gas Producer Plants.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—H. W. Greenwood: The Manufacture of Paper for Photographic Purposes. Historical—Hand-made Paper—Machine-made Paper—Raw Materials—Preparation—Beating—Sizing—Making—Finishing and Baryta Coating. Faults of Manufacture and their Effect on Emulsions—Testing for Faults, Impurities, etc.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—Various Members: Notes on Mounting.
CIRCLE OF SCIENTIFIC, TECHNICAL, AND TRADE JOURNALISTS (at Institute of Journalists), at 8.15.—Sir Richard Gregory and others: Discussion on Reviews and Reviewers.

WEDNESDAY, JANUARY 10.

ROYAL SOCIETY OF ARTS, at 3.—C. R. Darling: The Spectrum, its Colours, Lines, and Invisible Parts, and some of its Industrial Applications (Dr. Mann Juvenile Lectures (2)).
GEOLOGICAL SOCIETY OF LONDON, at 5.30.
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—C. F. Elwell: Design of Radio Towers and Masts: Wind Pressure Assumptions.
INSTITUTION OF AUTOMOBILE ENGINEERS, at 7.30.—Col. P. H. Johnson: Improvements in Efficiency of Roadless Vehicles.

THURSDAY, JANUARY 11.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 3.—R. A. Frazer: Testing Model Seaplanes (Juvenile Lecture).
OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—C. Davidson: The Amount of Displacement in Gelatine Films shown by Precise Measurements of Stellar Photographs.—J. E. Barnard: The Use of Ultra-violet Light in Microscopy.—F. W. Preston: Pitch.—T. Y. Baker: A Prismatic Astrolabe.
INSTITUTE OF METALS (London Section), (at Institute of Engineers, Inc.), at 8.—W. E. Hughes: Some Aspects of Electro-deposition.
CAMERA CLUB, at 8.15.—J. S. Wells: Criticism of Members' Prints.

FRIDAY, JANUARY 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. A. S. Eddington and A. V. Douglas: The Progression of Stellar Velocity with Absolute Magnitude.—J. Evershed: Note on the Corona of 1908.
MALACOLOGICAL SOCIETY (at Linnean Society), at 6.
INSTITUTION OF HEATING AND VENTILATING ENGINEERS, INC. (at Engineers' Club, Coventry Street), at 7.—Dr. B. R. Wingfield: Automatic Temperature Control.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. A. Stigant: Transient Phenomena arising in Transformers from Switching Operations.
ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—H. Butler: Some Unusual Cataract Operations.—C. Killick: The Treatment of Conical Cornea.

SATURDAY, JANUARY 13.

GILBERT WHITE FELLOWSHIP, at 2.15.—Visit to the Geological Museum, Jermyn Street.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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The British Empire Exhibition, 1924.

THERE is to be held, from April to October 1924, in Wembley Park, six miles by road from the Marble Arch, London, on ground occupying about 150 acres, a great exhibition displaying the immense resources, both industrial and productive, of the British Commonwealth, which now extends over one-quarter of the known surface of the globe and has a population exceeding one-quarter of its inhabitants. Its main purpose is to promote the exchange of raw material and manufactured goods within the Empire, an entirely worthy object. As the prospectus says, "We possess every kind of climate, every kind of mineral wealth, every potentiality that is known to the world. We have the best race of men to use and develop them." Under the present seriously disturbed commercial conditions, the value of the general trade of the United Kingdom in 1921 was, of imports, 1,085,500,061*l.*, of which the British Dominions supplied 303,859,326*l.* and foreign nations 781,640,735*l.*, and of exports 810,318,848*l.*, of which the British Dominions took 292,393,701*l.* and foreign nations 517,925,147*l.*

In 1913 we imported from Germany 1,731,000*l.* worth of synthetic dye-stuffs and 146,000*l.* worth from Switzerland, and it is estimated that we bought from British producers about 100,000*l.* in value. Yet the coal-tar colour industry began here both scientifically and commercially from the incidental discovery by Perkin, while engaged in another organic investigation, of a mauve colouring matter derived from coal-tar. It was in 1854, when Perkin was sixteen years of age and a student at the Royal College of Chemistry, Queen Street, London, under A. W. Hofmann, formerly of Bonn University, who was appointed at the instance of Prince Albert (the chief promoter of the Great Exhibition of 1851) director of the Royal College in 1845. From 1856 to 1865 Hofmann was chemist to the Royal Mint. He afterwards went to Berlin as professor of chemistry, where his work covered a wide range of organic chemistry. Perkin's discovery, having regard to our vast supply of raw material, led to the confident anticipation that Great Britain would in future be the dye-producing country of the world. But this was not to be. Its development, mainly because of the lack of facilities here for the supply of adequately trained scientific men, and because of the advanced condition of German scientific education which had been sedulously fostered, took place in Germany, and for the future years our textile and other industries, to the extent of their output of dyed goods (which now exceeds in annual value 200,000,000*l.*), were dependent for the supply of synthetic dye-stuffs upon Germany and Switzerland.

The importance, however, of a large supply of scientifically trained men, especially in chemistry, and the production of synthetic colouring matters on a large scale, sufficient to entitle it to rank as a chief key industry, have not merely an industrial significance; they have military aspects as well, since the discoveries and the applications of science may be used for evil purposes as well as for good, as the history of all wars shows. During the great war the Germans resorted to the use of poison gas, and thus started a course of "chemical warfare." The production of poison gas in its many forms was made possible because Germany had a fully developed dye-stuff industry, not merely in its personnel, but also in the perfection and extent of its plant, and the organic substances which were used and the methods employed were closely related to those required in the manufacture of synthetic colours. The Allies entered upon similar methods of attack, but in order to provide the means, except in the case of one large manufacturing firm producing dye-stuffs in Manchester, they had to erect special factories for the purpose.

If, however, we succeed in establishing coal-tar dye industries on a scale sufficient to meet the demands of our manufacturers, alike in quality, quantity, and price to those of our foreign competitors, we shall no longer have any cause for fear either in respect of our industries or in the event of war. But in order to achieve this and other desirable aims, we have to emulate the spirit and adopt the means and methods of the most progressive nations for the encouragement of scientific research and its application, together with the opportunity of advanced education for all who are worthy to receive it. The experience to be gained from previous exhibitions on a similar scale held at home and abroad, and the results accruing therefrom, should not be overlooked. The British Empire Exhibition to be held at Wembley, if it is not to miss a serious and fundamental purpose, must awaken a spirit of emulation for a wider extension of the means of knowledge and better conditions whereby its fruits can be achieved.

The Great Exhibition of the Industries of All Nations, of 1851, was remarkable from the fact that the building covering twenty acres of ground was erected of glass and iron after the designs of Joseph Paxton—a fine example in itself of the genius of the English engineer and a triumph of his technical skill. The exhibits were arranged under four heads: 1. Natural productions; 2. Machinery; 3. Manufactures; 4. Works of Art. It was attended by upwards of six million people of all nations. It was a financial success, the profits of which were invested in land at South Kensington on which numerous institutions for the advancement of science and art have been placed. "There began with it," says J. Scott Russell in his book on "Systematic Technical Education," "a series of competitive trials of intelligence and skill between the citizens of the different civilised nations of the world." We were supreme in the sphere of modern manufacturing machinery, but in respect of matters of taste and artistic design and skill we were far behind the French. The direct fruit of it all was, so far as this country was concerned, to be found in the organisation of the Science and Art Department (1853), whereby was brought within the reach of the workman, whether engaged in a mechanical or artistic handicraft, the means of study and experiment in the principles of his occupation. It reacted similarly on the educational policy of foreign nations, especially in France and Germany. They established schools of applied science according to the special needs of the town or industrial centre, the results of which were seen in the exhibition held at Paris in 1855, and especially in the International Exhibition held at South Kensington in 1862. There was abundant evidence that while we had progressed greatly in artistic taste and skill in design and workmanship, other nations had advanced in the industrial applications of science. There was Prussia with her ingots of Krupp steel, Switzerland with her fine display of Schönbein aniline colours, America with her automatic machines, Italy with her manufactures of classic earthenware, France with her fine steam-engines for her marine service.

"It was [however] the exhibition of 1867 in Paris," says J. Scott Russell (he was one of the English jurors), "which gave the nations, and especially England, a final lesson. By that exhibition we were rudely awakened and thoroughly alarmed. We then learnt, not that we were equalled, but that we were beaten—not on some points, but by some nation or other on nearly all those points on which we had prided ourselves."

There was shown the engineering products of a great establishment at Creusot in Eastern France concerned with mining, smelting, locomotive building, and other branches of commercial machinery in serious competition both in quality and price with like products from England. In addition to abundant raw material on the spot, coal and iron ore, the workers had the advantage of a systematic o ganisation of technical schools, which contributed very largely to the satisfactory results produced.

The Centennial Exhibition, held in Paris in 1900, furnishes another example of the value of these international exhibitions to the progress of industrial science. It was a marvellous display of executive skill and arrangement, and is well worthy of the closest study. Whether regarded from a constructive and engineering point of view, or from that of form and colour, the various features of the exhibition were endless in their variety and offered the most suggestive examples to the engineer, the designer, and the artist. A striking feature of the exhibition was the extent of space given to the display of facilities of education in France from the primary schools to the most advanced means of scientific and technical training. This was not confined solely to France, but other countries joined in it, notably the United States of America, which made a fine display. The exhibit arranged by South Kensington of gold-medal and other premiated works in the annual National Art Competitions challenged the admiration of foreign critics and caused the French authorities to say that they wondered, since such excellent designs could be produced, how it was that English manufacturers came so largely to France for designs. Another notable feature of the exhibition was the joint display of German scientific instruments. The exhibit was arranged collectively by ninety-eight German firms of instrument-makers, and was placed in charge of a scientific expert with qualified assistants, who undertook to explain and demonstrate to inquirers the purpose and merit of the various exhibits. Such an example of co-operation may be commended to the notice of the executive committee of the British Empire Exhibition.

The desirability of a special display of the educational activities of the various dominions of the Empire may also be suggested, such, for example, as was arranged with marked success for the United Kingdom at the Franco-British Exhibition held in London in 1910 in a specially adapted building, which included a lecture hall.

Having regard to the numerous research boards and committees for the investigation of scientific industrial problems under the auspices of the Department of Scientific and Industrial Research, the seventh annual report of which has lately been issued, and also to the existence of many separate societies for a like purpose, it seems appropriate that a special building or Hall of Science should be provided, in which lectures, experiments, and demonstrations illustrating many aspects of scientific work and discovery should be constantly arranged, as was done at the successful Scientific Novelties Exhibition just concluded at King's College, London. Such provision would give a living interest to the exhibits and serve to stress the the importance of purely scientific research in the development of industry.

Area of Distribution as a Measure of Evolutionary Age.

Age and Area: A Study in Geographical Distribution and Origin of Species. By Dr. J. C. Willis. With chapters by Hugo de Vries, H. B. Guppy, Mrs. E. M. Reid, and Dr. James Small. Pp. x+259. (Cambridge University Press, 1922.) 14*s.* net.

TO determine the value of Dr. Willis's book is not easy. The author delivers his message with enthusiasm and emphasis. "Age and Area," he reiterates, provides a penetrating and wholly new light on evolution. His supporters, four of whom contribute chapters to the book, endorse this opinion and tell us it is all right. Table after table exhibits special phenomena on which Dr. Willis relies. These tabulations seem to have been scrupulously made, and they certainly demonstrate some remarkable and novel results. The book is written with perfect sincerity and a conviction almost naive. Whatever its worth may prove to be, it is an honest attempt. So imposing an array must produce an effect in the mind even of the critical. But there are disquieting features. Repetition of the bald assurance that Age and Area is the true faith should be unnecessary. A judicious advocate would leave that conclusion to flow more quietly from the evidence. When, for example, we read, "As one of our leading ecologists says in a letter to me, and underlines, 'this will be strongly in favour of your Age and Area hypothesis,'" we remember seeing testimonials like that elsewhere and in more mundane application. But though the reader's scepticism is thus instantly aroused, the matter is worth careful attention, for to have hit on a new method of investigating even a part of the theory of evolution is no common achievement, and that the author has done this cannot in fairness be denied.

The main idea is not difficult to grasp. It is simply that, subject to various provisos, the area which a species "occupies" upon the earth is a measure of its antiquity in evolution. "Occupy" is scarcely a fortunate word in so formal a definition. The area "occupied" by a species has immediately to be explained as meaning the area over which the species *extends*, or has extended as shown by the fossils. Lingula lives now in the Chesapeake and in Philippine waters, but to speak of it as "occupying" the whole world would be confusing, even though it is found fossil in many countries.

A species once evolved is conceived as spreading in an ever-widening circle, much as a culture may do, inoculated upon a gelatine plate. If the medium be homogeneous and growth be undisturbed, the size of the circle will be a function of the age of the culture until the medium is covered. The species or genera in the course of their dispersal are held to throw off new species and new genera, each of which again spreads concentrically from the focus of its inception. The throwing off of these new forms of life is regarded by Dr. Willis as a "casual" process, and regarding it some very definite inferences are drawn, of which we will speak later.

Now every evolutionist agrees that, *apart from disturbing elements*, area is a measure of age. If the matter rested there nothing would be in dispute, but nothing fresh would have been contributed to the discussion. We are, however, asked to believe that in practice this mode of estimating the age of a species is, on the whole, trustworthy: that endemic species and rarities in general can and must be for the most part accepted as new starters in evolution, and not as survivors. That is, of course, a paradox, but it constitutes the main thesis of the work. Dr. Willis takes the floras of Ceylon and New Zealand into special consideration, besides those of other isolated places, mountain tops and remote islands, and in brave defiance of all that science has hitherto taught us regarding the peculiar plants and animals limited to such localities, he tells us that, on the whole, the reason why those creatures occupy such small areas is that they have not yet existed long enough to have spread far. If any one objects that in application to the special cases which immediately suggest themselves, Sphenodon, the dodo, Leucodendron, etc., such a contention is preposterous, Dr. Willis would reply that he knew as much already, and that he is concerned not with special cases, but with averages and general propositions. He is within his right. The second proviso is that comparative estimates of age are only to be based on area when forms within the same "circle of affinity" are compared.

Everything then turns on the computation of these averages and on the criteria by which "circles of affinity" are to be recognised. Unfortunately no means are suggested by which we are to tell whether a species or genus is a novelty or a relic, and obviously none can be forthcoming. We may make shrewd surmises, but if things like that could be declared with certainty the study of evolution would be on the way to becoming an exact science. Meanwhile estimates of age based on area "occupied" must be exceedingly hazy. Giant tortoises live in the Mascarenes and in the Galapagos, and therefore must be reckoned ancient, as they doubtless are. When they become extinct, say in the Mascarenes, which they presumably will, they would start again as novelties at the bottom of the list, but for the accident that the remains of such creatures form conspicuous fossils. Of the New Zealand shrubby Veronicas one, *V. elliptica*, occurs also in Fuegia; having the widest recorded range it must be deemed by far the oldest of these species. Once extinct in either locality, whether Fuegia or New Zealand, it would be ranked with the rest of the New Zealand species as new mutations.

Then again the surface of the terrestrial globe is, as we all know, a medium of complex heterogeneity. By no provisos, safeguarding clauses, or anticipatory exclusion can considerable areas be defined in which dispersal may be observed which has not been promoted or limited, diverted or arrested, by countless interferences. Very rarely, if ever, do we find that reasonable uniformity and constancy of conditions, even in space, let alone time, without which we are warned the theory must not be applied. In areas which may be judged most uniform at a given point of time, the operation of sharply limiting causes is manifest. If, as in prairies and steppes, for hundreds of miles the conditions appear geologically and meteorologically uniform, the mere presence of living things introduces heterogeneity. Dr. Willis is well aware of this. In one of his best chapters he discusses "barriers" in the widest sense, and he makes us realise how difficult it must be for a new-comer species to get a footing or to spread among plant-associations already established. On the Central Asian steppes, for example, one can distinguish on the remote horizon by their colour the spots where encampments have stood. These patches are mainly characterised by the presence of nettles, which grow in such places. Nettles, as Dr. Willis remarks, are very easily dispersed by wind, yet nowhere else do they establish themselves in the Artemisia steppes—only in places which man and his animals have made fit for their growth. European weeds abound in the Eastern States where the soil has been cultivated, but few invade patches of unbroken territory. Quantitative estimates of the allowances to be made for heterogeneities and barriers in general cannot be attempted. Therefore in the hope that the heterogeneities will be so many and so various as to cancel, a reservation is introduced to the effect that the groups of species to be compared should each be not less than ten in number. But the difficulty is a real one, and in dealing with any troublesome or unconformable phenomena these considerations provide endless loopholes for escape.

A still more formidable difficulty is encountered in the endeavour to declare which classes of forms may be compared legitimately with the object of determining their relative ages from the areas they occupy, and which are not comparable. To have some consistent criterion by which comparables may be recognised is absolutely essential to the application of the method. Nevertheless no information offered reduces the difficulty materially. We are told that only forms in the same "circle of affinity" are to be taken—a definition which is plainly left vague deliberately. How this is to be construed we are never precisely told. The species to be compared must be more or less alike in their modes or at least in their facilities of dispersal—a property we have commonly no means of estimating in any trustworthy or quantitative way. Unless I have misunderstood the chain of reasoning, its validity is severely strained at this point.

The author is shy of special illustrative examples and they need not be essential to an argument dealing solely with general propositions, but in a chapter contributed by Prof. Small we are provided with an illustration on the largest scale. There we are given to understand that the natural order Compositæ is a "circle of affinity" to which the method of Age and Area can be properly applied. If a group so polymorphic and heterogeneous as the Compositæ constitute a "circle of affinity," the members of which can be compared for these purposes, where are we to stop? The tribes of Compositæ are arranged in a genealogical tree upon which the presumed point of origin of each is marked, and we are told that the order of evolution as given on the tree, which has been constructed from anatomical data, agrees substantially with the numerical estimate of the areas occupied by each tribe. Needless to say, numerous eminent botanists have arranged the tribes in almost as many other ways, probably with equal propriety. These speculative genealogical trees, once fashionable, are, I had supposed, discredited. All that they can attempt is the display of a logical order of interrelationship based on the modifications of the special set of organs selected as a criterion; for the Compositæ this order will differ with each set of organs chosen. In support of Prof. Small's arrangement he gives an imposing tabulation of the geological levels in which each tribe is believed to have arisen. Not until the text of Prof. Small's previous papers is consulted does a reader discover that this tabulation is almost wholly conjectural. In a well-written and judicious chapter by Mrs. Reid, who discusses what palæobotany can produce in support of Age and Area, we find no such confident pronouncements. The inclusion of the chapter on the Composites reflects more credit on Dr. Willis's candour than on his scientific judgment. The propositions made in the name of the theory there stand forth with a neglect of caution which Dr. Willis himself seldom exhibits.

For the reasons given, the theory of Age and Area, except in so far as it is truistical, is as yet of doubtful value, and unless amended to meet the difficulties specified it cannot be applied with any confidence. I suspect that certain predictions respecting the flora of the islands near New Zealand, which, though made in advance, as we are frequently reminded, were fulfilled, did not involve any feat of which common sense would have been incapable.

Dr. Willis is a great advocate of the theory of mutation in its crudest form. The speculation now presented to us as Age and Area is a development of an idea which came to him when he reflected on the fact that in Ceylon several endemic species are limited to small areas, though sometimes associated with related species of wider distribution. The theory of mutation of de Vries appeared at about the same time, and Dr. Willis asked himself whether the wonderful "mutations" which had been reported in Œnothera might not exemplify the process by which the Ceylonese endemics had been begotten by the "wides," as he calls them. Endemics had previously been held to be largely relics. In the new light they become "in the vast majority" novelties, about to spread with the lapse of time in widening circles. On any theory of evolution endemics must be in part novelties and in part relics; but why, apart from the theory of Age and Area, we should believe that endemics are in such great majority novelties I do not clearly understand, for though we know little of origins we are certain that myriads of species have become extinct. It is surely contrary to all expectation that the process of extinction should be in general so rapid, and the final endemic phase so short that the number of species in that final stage of existence should be insignificant.

The supposition implies the optimistic but embarrassing corollary that a species, once established, is in no great danger of extermination unless some catastrophic or lethal change occur in the conditions of life. *Cupressus macrocarpa* is admitted to be in danger because, as we are told, the Monterey peninsula is drying up. This is used as the stock illustration of the mode in which authentic extinction should occur. As it serves three times in this capacity, bearing perhaps an undue burden in the argument, we may infer that examples of extinction through predicable secular change are not plentiful. Unless, indeed, the change can be traced directly or indirectly to human action, the cause whether of gain or loss of territory is apt to be a mere matter of surmise, for though losses are so familiar we must not forget that there are also mysterious gains—even in our own area. Who shall say what gave *Capros aper* its chance? A doubtful British species in the time of Couch, it became a nuisance in the trawl, some time at least in the eighteen-eighties. How did the showy *Plusia moneta* become a common British moth? No one recorded it here before 1890. Extinction must ensue from countless causes. If compelled to specify one class of cause as operating rather than another, we should regard the appearance of a new and antagonistic organism as by far the most formidable and effective agency of extinction; but we have only to glance at anthropological data to observe that no rule obtains as to the length of time which the process of extermination will take. Whatever doubts be entertained as to the significance of adaptation in delimiting *specific characters*, there can be none that survival is determined by selection according to the balance of the profit-and-loss account on the workings of the machine.

Wondering at the Ceylonese endemics, Dr. Willis asks rhetorically, "Had one arrived in Ceylon just in time to see the disappearance of a considerable flora?" We may reply, What more likely? Is the alternative interpretation, that he had come in time to attend the birth of a new flora, more acceptable? About half the endemics of Ceylon, he tells us, occur on the tops of single mountains or small groups of mountains. Does he really suppose that future ages will witness the spread of such species downwards from the mountain tops?

In reading the chapter on the origin of species and the many passages in which references to mutation are made, I see signs that Dr. Willis, though making large assumptions in the name of genetical experiment, is not sufficiently conversant with the present state of genetical science. Both from observation and from experiment, the certainty that variation is largely discontinuous has been established. If for the moment we abrogate the consideration of inter-specific sterility we might declare that forms mistakably like new species do actually arise suddenly. But this is scarcely mutation as contemplated by the theory of Age and Area. If we were told categorically which "wide" species is regarded as the putative parent of which endemic, we should be in a position to consider how far this interpretation is consistent with what we know of variation. From anything so precise Dr. Willis shrinks. Here and there we get a glimpse of what he would like us to infer. The endemic *Coleus elongatus*, for example, he is inclined to claim as the immediate product of *C. barbatus*, from which it differs in some ten respects. The shrubby Veronicas are characteristic of New Zealand; if pressed Dr. Willis would point to the "wide" *V. elliptica* (mentioned above) as their putative parent. Similarly the Chilian *Ranunculus acautis*, or alternatively *R. crassipes* (found in Kerguelen), which both occur in New Zealand, might be adduced as the parent of the endemic Ranunculi of those islands. Though undeniable as possibilities, we have to consider what warrant for such guesses can be drawn from the observed facts of variation. The answer is quite clear that up to the present scarcely anything comparable has been observed. The "rogue"-peas, the "fatuoid" mutations of oats (Nilsson-Ehle and later Marquand), with perhaps a very few more, are all that can be quoted as precedents, none certainly in point. No one familiar with genetical work would be disinclined to entertain the supposition that such groups of endemics as the New Zealand Veronicas may not improbably be co-derivatives from one or more crosses; so also may the hosts of "species" of Cratægus which Prof. Sargent has described largely as endemics on derelict farms of the Eastern States. But to establish these propositions, genetical and doubtless cytological work on a vast scale is required, and far too little has been yet done to justify the bold assumptions lightly made in the doctrine of Age and Area.

The evidence adduced by de Vries from Œnothera which led him to propound the theory of Mutation is clearly enough the precedent which Dr. Willis has at the back of his mind. From the first the meaning of the Œnothera work was ambiguous. The researches of Renner and of Heribert-Nilsson have now shown that those early suspicions were justified, and that the "mutations" of Œnothera are not genuine illustrations of the origin of species by variation in descent from a pure form. Had de Vries grasped the implications of Mendelian analysis, he could never have so interpreted them with any confidence. The few words in which he conveys his benediction on this new venture should be read with caution and reserve by persons unfamiliar with the history they purport to relate.

Unconvincing as the main argument of "Age and Area" appears, the reader will find in it some curious and interesting discoveries. Of these the most remarkable is the uniformity of the statistical distribution of species among the genera of various and most dissimilar forms of life, both plants and animals. The monotypic genera, with one species each, are always the most numerous, commonly forming about a third of the whole group, the ditypics, with two species each, are the next in frequency, genera with higher numbers of species becoming successively fewer. Set out graphically, according to the number of species they contain, the genera exhibit what is here called a "hollow curve" of frequency, and there is no gainsaying the fact that these curves, though collected from such miscellaneous sources, have a remarkable similarity. Another curious feature exhibited by this marshalling of the genera according to the number of their species is not merely that the percentage of monotypes is largest on islands (as might be expected), but that it is exceptionally high in S. America and in Africa. The corresponding curves from several other regions are altogether different. I do not wholly follow the argument by which these features of regularity are interpreted as giving strong support for the theory of Age and Area. Whatever be the meaning of the regularity of the curve of frequency of species distributed according to genera, the occurrence of order in this unexpected place does not readily accord with the Darwinian view that specific diversity is primarily or closely dependent on fitness. That deduction, which looked so attractive in the superficial survey which was all that could be undertaken in Darwin's time, became practically untenable so soon as the phenomena of variation were accurately explored, and it is not surprising that close investigation of another part of the species-problem has revealed a similar weakness.

On the other hand, though the point is a minor one, the considerations collected under the title "Size and Space," though adduced as fatal to the theory of Natural Selection seem to have little cogency. On the average, genera with more species are shown to extend over greater space, and hence the area occupied by a genus corresponds roughly with the number of species it contains. What else could we expect? A large college, with a larger and more varied supply of competitors, commonly shows more successes (and indeed more failures) in more varied departments of activity than will be achieved by a smaller establishment.

One excellent purpose Dr. Willis's book will certainly serve. It will renew the debate on the mode of evolution, which for many reasons has of late years languished. Whatever doubts arise regarding the new deductions, Dr. Willis once more makes geographical distribution a live study, showing quite unexpected lines along which it may be pursued. The delimitation of floral areas—or, for that matter, zoological areas too—was, as he says, a dull and almost futile exercise of scholasticism. The introduction of statistical methods, here altogether appropriate, offers great possibilities.

In stronger hands a still greater effect might have been produced. The style of presentation scarcely attains the level required of such works by an age not over-exacting in that respect. Finish is no longer demanded of scientific authors, and we have come to suppose that loose writing is compatible with clear thinking. None the less it makes very difficult reading. Those who are not alienated by such blemishes will find the book interesting as a challenge. How far the new ideas are of value and how many of them are fallacious we shall scarcely know till they have been tried in practice over wide fields of experience, and examined in perspective from many aspects.

W. BATESON.

The Internal Combustion Engine.

The Internal-Combustion Engine. By Harry R. Ricardo. Vol. 1: *Slow-speed Engines.* Pp. vii+488. (London and Glasgow: Blackie and Son, Ltd., 1922.) 30*s.* net.

MR. RICARDO has completed the first volume of his promised book on the internal combustion engine, and according to the preface "hopes shortly to be able to complete the second." Seeing that the present volume deals entirely with the slow-speed engine, and was for the most part written many years ago, it is to the volume to come, dealing with the modern high-speed engine and embodying the results of recent researches, that the readers of NATURE will turn with greater interest. Mr. Ricardo is giving us two books rather than two volumes of one book, and it is a pity therefore that the volume now completed is not provided with an index.

The development of the internal combustion engine coming so much later than the steam engine, it was natural that during infancy its progenitors should be more disposed to seek the aid of physics and chemistry as god-parents than had been those of its rival, the steam engine, which received this baptism only in riper years. It is refreshing to a student of science to see how—and in Mr. Ricardo's contributions in particular—the limits of internal combustion engine design are studied in the light of modern knowledge of the detonation of compressed gases, flame temperature and flame velocity, the effect of change of specific heat, the effect of mass on dissociation. The results are very striking. The investigator of a new problem, instead of groping for a solution in the dense thicket of possibilities, is able, by using the laws of physics and chemistry as guides, to mark off the possible from the impossible, and so to reduce the area to be cleared to very much smaller dimensions. One catches the process at work in the volume before us, but for the culmination of its productiveness one has to wait for the stimulus of the war period with its impetuous demand for new engines for more and more effective flight. The impetuosity of this demand is illustrated by M. Rateau's recent paper at the Institution of Mechanical Engineers: two long-unsolved problems of the internal combustion engine are the compounded engine and the gas turbine: the needs of aviation are shown by M. Rateau insistently to demand some sort of solution of both these problems at once, to enable flight at really high altitudes to be possible.

In the present volume Mr. Ricardo covers a wide field: all important types of slow-speed engine are described. Some of the work is thus rather that of editor than author, but opportunity for the exercise, at its best, of the latter rôle is seen particularly in the sections relating to engine balancing and piston friction, where the subject is dealt with in masterly fashion and cleared of the unnecessary complication so often found in other books on this subject. Some writers have photographic vision, Mr. Ricardo's is selective and acute. We receive this volume of his book with interest, and look for the second with pleasure. H. E. W.

Lord Moulton.

The Life of Lord Moulton. By H. Fletcher Moulton. Pp. 287+8 plates. (London: Nisbet and Co., Ltd., 1922.) 15*s.* net.

Mr. Fletcher Moulton's life of his father is an attractive volume which gives a vivid picture of the career of a man of remarkable ability. Beginning with very scanty financial resources, Lord Moulton spent some three and a half years as an assistant master after leaving school before he entered for a scholarship at Cambridge. During this time, however, he carried off three successive scholarships at the University of London, and so established a record of success which remained unbroken during his time at Cambridge.

Two consecutive chapters describe Lord Moulton's work at the Bar and on the Bench, first of the Court of Appeal and then as a Lord of Appeal and a member of the Judicial Committee of the Privy Council. The latter part of the book is given up to a description of his work during the war, and to those successful efforts which made it possible to assert that in this country, at any rate, empty shells were never kept waiting for supplies of explosives with which to fill them. For a solution of this most difficult problem of supply Lord Moulton relied mainly on the production and utilisation of a very large output of ammonium nitrate, and the principal chapter devoted to this period of Lord Moulton's life bears the appropriate title of "The Fight for Amatol." In this fight he was handicapped, not only by the inertness of this explosive, which in the early days created a well-deserved prejudice against it, but also by the difficulty of turning down inferior and sometimes fraudulent substitutes when these were advocated with the aid of influential supporters.

The most notable of these substitutes was "Halakite," a new and wonderful explosive, alleged to be capable of acting both as a propellant and as a high explosive, with the additional advantage of containing no nitroglycerine. The first samples supplied by the inventor were found, however, to contain 20 per cent. of nitroglycerine, and samples supplied to the French Government consisted of British Mark I cordite coloured yellow with lead chromate. The twenty pages devoted to this case are probably a fair measure of the amount of time that was absolutely wasted by Lord Moulton's department when the inventor had found an editor sufficiently influential to work up a scandal but also sufficiently ignorant to be taken in by his claims. Lord Moulton himself had, however, a remarkable ability for detecting real promise in the propositions put before him, and in nearly every case where a difference of opinion arose, subsequent experience showed that Lord Moulton was right and his critics were wrong. This was notably the case in reference to amatol, which remained not merely in service throughout the war, but is generally recognised as providing one of the best fillings now available for H.E. shells for land service.

A chapter is devoted to Lord Moulton's scientific work; but although a summary is given of his experiments with Spottiswoode, the usual references by which a scientific reader would trace this work are not given. An examination of the Royal Society's Catalogue of Scientific Literature shows that these experiments are described in two papers bearing the titles "On the Sensitive State of Electrical Discharges through Rarefied Gases," Part I. (Phil. Trans., 1880, 170, 165-229), and "On the Sensitive State of Vacuum Discharges," Part II. (Phil. Trans., 1881, 171, 561-652). In the spacious days of forty years ago it was possible for a man of pre-eminent ability to secure election as a fellow of the Royal Society on what might now be regarded as a mere sample of the scientific work of which he was capable. Under these conditions Lord Moulton's election in 1880 was a natural sequel to his partnership with Spottiswoode, following upon his earlier record as Senior Wrangler and Smith's prizeman. His greatest service to science was, however, undoubtedly the whole-hearted co-ordination of chemical enterprise which he brought about during the war, and then strove to perpetuate in time of peace.

Lord Moulton was educated at Kingswood School, and maintained his interest in the school to the end. During the first year after the Armistice he took part as an old boy in the annual dinner, which had been allowed to lapse during the war, and also distributed the prizes at the school where his first academic success had been won. A Moulton scholarship founded by his son will perpetuate his association with the school, and a scheme is already in progress for supplementing this by a stained-glass window in the chapel recently erected as a war memorial.

Our Bookshelf.

Effects of Winds and of Barometric Pressures on the Great Lakes. By John F. Hayford. (Publication 317). Pp. v+133+16 plates. (Washington: Carnegie Institution, 1922.) 2.75 dollars.

This book records what is probably the most complete investigation yet made of the effect of winds and atmospheric pressure on the slope of the surface of great sheets of water. It deals with Lakes Erie and Michigan, which are large and of fairly irregular outline and bed-contour, and are situated in a region where the meteorological conditions are well observed. Continuous records of water-level are afforded by several gauges on each lake, designed to smooth out the local wave-fluctuations. Mr. Hayford has constructed an elaborate theory connecting the daily change of level of the water surface, as revealed by each of these gauges, with the north and west components of barometric gradient on the current and preceding days; proportionality factors, varying with the station, are derived by the method of least squares from large numbers of observations. The winds, being more rapidly variable than the barometric gradient, are considered from hour to hour; the hourly change of level at any gauge station is related to the hourly changes in the values of a certain function of the wind-velocity during the hour in question and the following hour; the said function is derived partly by theoretical reasoning. The numerical constants of the theory have been worked out in great detail, in order that the real changes of content of the lakes may be derived from the gauge-readings with sufficient accuracy to enable the evaporation from the surface to be estimated in varying circumstances.

British Meteorological and Magnetic Year Book, 1920. Part III. Section 2. *Geophysical Journal,* 1920. (Air Ministry: Meteorological Office.) 1*l.* 5*s.*

This publication comprises the daily values of the meteorological and geophysical elements at three observatories of the Meteorological Office, namely, Kew Observatory, Richmond; Valencia Observatory in Ireland; and Eskdalemuir Observatory, Dumfriesshire; and at the St. Louis Observatory in Jersey: daily values of solar radiation at South Kensington; wind components at fixed hours at four anemograph stations; tabulations of occasional soundings of the upper air; and results of observations of cloud and aurora. The annual supplement contains upper air temperatures by means of soundings with registering balloons and aeroplane ascents, giving monthly and annual averages with averages for the period 1917–1920; notes on seismological work at Eskdalemuir Observatory; the water-level recorder at Kew Observatory; and tables of monthly means of magnetic and electrical data for Eskdalemuir and Richmond respectively.

The introduction to the volume gives all details and necessary references to the actual data here brought together, following, in most cases, the arrangement of former years. It is to be noted that the soundings with pilot balloons and temperature determinations by means of aeroplanes will be discontinued, as these data now appear in the Daily Weather report.

The volume, like its predecessors, forms a valuable contribution to the study of the meteorological and geophysical elements, and the homogeneous nature of the data will be thoroughly appreciated by those who utilise the information.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1923. Edited by George E. Brown. Sixty-second issue. Pp. 808. (London: H. Greenwood and Co., Ltd., 1922.) Paper, 2*s.* net; Cloth, 3*s.* net.

It is a matter for congratulation that the abatement in the cost of printing papers has allowed of the use of paper of a quality superior to that which had to be employed for some of the preceding volumes of the Almanac. The arrangement of the matter is the same as heretofore. The Editor takes for the subject of his special article "What Camera and Lens to have," and hopes that those who are asked for advice on the subject will refer their questioners to it, and so provide a full answer and save their own time. Besides the calendar, which gives the public holidays in more than thirty different countries, there is a directory of Photographic Societies and other bodies, giving much information concerning each. The Epitome of Progress is the largest section, and the items are well classified and indexed. The usual statistical matter, photographic formulæ, and tables of all sorts, complete a most useful, practical and up-to-date reference book.

Proceedings of the Aristotelian Society. New Series, Vol. 22: Containing the Papers read before the Society during the Forty-third Session, 1921–1922. Pp. ii+242. (London: Williams and Norgate, 1922.) 25*s.* net.

The volume contains the papers of the Session 1921–1922, abstracts of which have appeared from time to time in our Society notices. It reflects the great interest aroused by the discussion of relativity problems. Einstein's theory is the subject of a symposium to which Prof. Wildon Carr, Prof. T. P. Nunn, Prof. A. N. Whitehead, and Dr. Wrinch contribute. We may also direct attention to two papers, one by Prof. Johnstone on "The Limitations of a Knowledge of Nature," and one by Mr. Tavani on "Physical Space and Hyperspaces," both of which are of special scientific interest.

The Supremacy of Spirit. By C. A. Richardson. Pp. viii+159. (London: Kegan Paul and Co., Ltd., 1922.) 5*s.* net.

Mr. Richardson in this short volume sets forth, in clear and concise terms, the philosophical theory which he expounded in his "Spiritual Pluralism" in order to show its relation to the new psychology and its bearing on the somewhat dubious methods and even more elusive facts of psychical research. He states the case for psychical research, in its claim to be a purely scientific investigation, as well as it can be stated, but the argument is too brief to deal at all adequately with the scientific objections, those which are completely free from prejudice.

Letters to the Editor.

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

The Spectrum of Neutral Helium.

IN a letter to NATURE of November 25, p. 700, concerning my first communication (NATURE, August 19) on this subject, Prof. Raman expresses the opinion that the representation of helium lines derived from my assumption of the mutual apathy of the two interatomic electrons has a purely arithmetical character and would thus be deprived of any "real physical basis."

Disregarding a number of remarks reducible to the laceration of the empirically established series, a regrettable feature pointed out by myself (*Astrophys. Journ.*, September 1922), it will be enough to reply here to Prof. Raman's chief and apparently strongest objections. These are two: first, that the numerous coincidences yielded by my formula are simply explicable as so many "fortuitous arithmetical coincidences," and, second, that the particular value (109723) of the Rydberg constant N used in that formula is, in general, inadmissible, this value belonging legitimately to He^+, with a single electron, but not to the neutral atom with its two electrons.

Now it so happens that precisely these two points have steadily occupied my attention since the formula was first published, and I am therefore able to reply to both of them without delay. The corresponding details of reasoning and numerical data being all given in a paper just communicated to the American Physical Society (for its Boston meeting, December 27-29), to which readers may be referred, it will suffice to describe here the bare results.

1. Consider only those lines for which the final quantum numbers lie between 3 and 8, and the initial ones between 4 and 20, which fall within the interval $\nu = 17{,}000$ to $37{,}850$. The total number of such distinct lines is $n = 680$. Among these there are $k = 45$ lines covering observed helium lines, with a mean deviation $|\delta\nu| = 2{\cdot}57$. In the considered ν-interval there are in all 97 observed lines. Whence, the mean (geometric) probability of hitting an observed line in a single trial by mere chance, $p = 0{\cdot}0182$, and the probability P of hitting k or more such lines in n (680) trials, by Bernoulli's theorem, $P = 1 - \Theta(x)$, where $\Theta(x)$ is the error-function and

$$x = \frac{\Delta}{\sqrt{2p(1-p)n}}, \quad \Delta = |k - pn|.$$

In our case $pn = 12{\cdot}40$, $\Delta = 32{\cdot}60$, and therefore the probability that our set of 45 coincidences should be "fortuitous" is

$$P = 1 - \Theta(6{\cdot}61),$$

which is a little less than $1{\cdot}7 \cdot 10^{-13}$—small enough to discard every suggestion of the play of blind chance. This conclusion is considerably strengthened when other groups of coincidences tabulated in the *Astrophys. Journal* are similarly treated.

Of particular interest, in this and other respects, are the 18 lines of the type $\left(\frac{m_1 \cdot m_2}{4 \cdot 8}\right)$, and another group of three lines, each of the type $\left(\frac{5 \cdot m}{4 \cdot 4}\right)$ and each covering an empirical "combination" line of the "doublet system."

2. Let m be the mass of each of the two electrons, M that of the nucleus, and $\epsilon = m/M$. Taking account of the wobbling of the nucleus, through which the otherwise indifferent electrons perturb each other indirectly, and rejecting terms in ϵ^2, etc., the energy of the system in any stationary state, say $n_1 = \iota$, $n_2 = \kappa$, is found with comparative ease. This divided by ch gives the corresponding "term," say $T_{\iota\kappa}$, our ν being the difference of two such terms. If this be written

$$T_{\iota\kappa} = 4N_{\iota\kappa}\left(\frac{1}{\iota^2} + \frac{1}{\kappa^2}\right),$$

then $N_{\iota\kappa}$, the "Rydberg constant" belonging to the particular pair ($\iota\kappa$) of electronic orbits, is a certain symmetrical function of the integers ι, κ, and of the mutual orientation of the two orbits. For the case of quasi-circular orbits (*i.e.* such as would become circular for $\epsilon = 0$ or no wobbling) the investigation given in the Boston paper leads to the interesting result

$$N_{\iota\kappa} = N_\infty\left[1 - \epsilon - \epsilon\gamma\frac{\iota^6 + \kappa^6}{(\iota^2 + \kappa^2)\iota^2\kappa^2}\right], \quad . \quad . \quad (1)$$

where N_∞ (about 109737) is the constant for $M/m = \infty$, and γ the time-average of the cosine of the angle between the radii vectores of the two trabants. This formula holds for any inclination (i) of the two orbits and for any phase difference (α) of the two electrons describing them.

Now, a purely kinematical reasoning gives for $\iota \neq \kappa$ the value $\gamma = 0$, and for $\iota = \kappa$,

$$\gamma = \gamma_{\kappa\kappa} = \tfrac{1}{2}\cos\alpha(1 + \cos i), \quad . \quad . \quad . \quad (2)$$

where α is the angular distance of one electron from the ascending node when the other electron just passes through it.

Since for $\iota = \kappa$ the arithmetical expression in (1) becomes equal to unity, we have

$$N_{\kappa\kappa} = N_\infty[1 - \epsilon - \epsilon\gamma_{\kappa\kappa}], \quad . \quad . \quad . \quad (1a)$$

which, by (2), can assume any value from N_∞ down to $N_\infty(1 - 2\epsilon)$, with $N_\infty(1 - \epsilon)$, the desirable He^+ value, just in the middle of the interval. If, *e.g.*, the orbits are coplanar and $\alpha = 180°$, we have $N_{\kappa\kappa} = N_\infty$, for then there is no wobbling; if $\alpha = 0$, $N_{\kappa\kappa}$ would reach the other extreme value, about 109709, and for $\alpha = 90°$ we should have the mean value (109723), which might even be made the only value if the lines of the type $\iota = \kappa$ are not to be very broad. There is thus no essential difficulty. Moreover, very few among my tabulated lines have $\iota = \kappa$.

For the overwhelming majority of those lines we have $\iota \neq \kappa$, when γ vanishes, and (1) becomes, no matter what the inclination of the orbits and the phase difference of the electrons,

$$N_{\iota\kappa} = N_\infty(1 - \epsilon), \quad . \quad . \quad . \quad . \quad (1b)$$

which is precisely the value (109722 to 23) used in my formula. This in itself seems to be a strong support for that formula.

LUDWIK SILBERSTEIN.

December 6.

Returning to my letter of December 6, I beg to supplement the same by a result of my last week's work, which seems to give the proposed theory a much stronger support than all probability estimates, for it represents *in toto* and orderly some empirical series of helium. In fact, guided by a few coherent items of my original table, I find that the whole *diffuse series of singlets*, denoted by $1P - mD$, is represented by

$$\nu = 4N\left(\frac{18 \cdot 2n}{20 \cdot 4}\right) \equiv N\left(\frac{9 \cdot n}{10 \cdot 2}\right),$$

two final and one initial quantum numbers being fixed. The other initial number $2n$ being given the successive values 6, 8, etc., or

$$n = 3, 4, \ldots 14,$$

the formula gives, with $N = 109721 \cdot 6$, all the twelve observed members of the series from $m = 2$ to $m = 13$, respectively, the first with a deviation of 5, the second within 0·7, and the remaining ten members within a fraction, ranging from 0·1 to 0·35 Å.U.

The possibility of reducing $4N$ to N, based on the fact that all numbers are even, is interesting, especially as it forces itself on us also in the case of the fundamental and the principal series of singlets, which, though less precisely but again orderly and without gaps, are represented by

$$\nu = 4N\binom{2n}{6} - N\binom{n}{3}, \quad n = 4, 5,$$

and

$$\nu = 4N\binom{14 \cdot 2n}{8 \cdot 4} - N\binom{7 \cdot n}{4 \cdot 2}, \quad n = 3, 4, 5, \ldots 14.$$

This reducibility (to *one* N), if interpreted physically, would mean that the helium nucleus attracts each of its electrons with only one-half of its total charge, as if its lines of force formed two bundles, each entirely engaged with one of the two trabants. Details concerning these three series and the last-mentioned possibility will be given at the coming Boston meeting of the American Association.

LUDWIK SILBERSTEIN.

129 Seneca Parkway, Rochester, N.Y.,
December 13.

Echinoderm Larvæ and their Bearing on Classification.

MAY I ask your permission for a short space in which to reply to Dr. Mortensen's letter published in NATURE of December 16, p. 806, under the title "Echinoderm Larvæ and their bearing on Classification." The points which Dr. Mortensen raises are two —namely (*a*) whether the Echinoderm metamorphosis is a metagenesis, *i.e.* an alternation of generations, or not, and (*b*) whether the fixed stage in the life-history of Asteroidea is a reminiscence of an ancestral condition or a secondary modification of development. I shall deal with the second point first. Dr. Mortensen states:

(1) That the group Spinulosa among Asteroidea are not primitive but modified forms and that the Paxillosa are the more primitive group, and that in this view certain modern systematists whom he quotes agree with him.

(2) That since the Astropectinidæ (Paxillosa) do not have a Brachiolaria stage in their ontogeny, this stage is not primitive and ancestral but secondarily intercalated where it occurs in the development of Spinulosa and Forcipulata.

I must confess that I am unconvinced by Dr. Mortensen's arguments. In his original work, reviewed by Dr. Bather, he forgot that the Brachiolaria larva was found in Spinulosa but referred it to Forcipulata only.

The systematists whom he quotes are neither palæontologists nor physiologists but—for the most part—students of the external features of preserved specimens only. Koehler (one of them) regards Hudsonaster, one of the oldest Asteroids known, as "voisine des Astropectinides," and W. K. Fisher also states that "typical Phanerozonia such as the Astropectinidæ are more primitive than the Spinulosa."

Now what these specialists are impressed by is the "phanerozonate" character of the Astropectinidæ, that is, the edging of the arms with a series of broad plates termed the "marginals." I have always protested against regarding this feature as a primitive character and in this protest I have the support of the best British authority on fossil starfish, W. K. Spencer. The fact is, the apparent marginals of these ancient starfish are not homologous with the marginals of the modern Paxillosa at all but are the adambulacrals. Reasoning from imperfectly described fossils and superficially described modern forms has completely misled the older systematists.

Ludwig, whom Dr. Mortensen quotes, was a worthy pioneer in the knowledge of Echinoderms, but he belongs in all his thoughts and views to another epoch. His classification, for example, of the Holothuroidea into Actinopoda and Paractinopoda has been completely disposed of by modern embryological research. In my letter of a year ago, I gave physiological and anatomical reasons for regarding the Astropectinidæ as Asteroids secondarily modified for a life on sand. I can only express the doubt whether Dr. Mortensen could have regarded the Astropectinids as primitive if he had ever thoroughly dissected one.

With regard to the homology of the stalks of the Bracholaria larva of the Asteroid and the Pentacrinoid larva of Antedon, I should like to reiterate the following facts:

(1) The larvæ are, broadly speaking, comparable; in both there is a long præoral lobe, a ventral stomodæum, right and left posterior cœlomic sacs.

(2) In both forms there is a fixing ("sucking") disc formed at *precisely the same spot*, and in both the præoral lobe is converted into a stalk.

Is it not infinitely more probable that the precisely similar stage of fixation is an original and ancestral feature in both ontogenies, and not as Mortensen supposes, ancestral in the Crinoid and secondarily intercalated in the Asteroid ontogeny?

Of course, the subsequent metamorphosis is very different in the two cases—but this difference I have correlated with the adoption of different feeding habits by two sections of the primordial Echinoderm stem. I have the support of Mr. Tate Regan, based on his study of a widely different group, that what he calls "habitudinal differences" are the basis of all differential evolution.

With regard to the "metagenesis" of Echinoderm larvæ, Dr. Mortensen states that in one species of Ophiuroid the whole larval body is reproduced by the remnant of the ciliated apparatus cast off at metamorphosis. This case is certainly unique among Echinoderm larvæ and I cannot accept it until Dr. Mortensen brings forward better evidence. In any case, it will not, even if true, alter our views as to the significance of the larva. May I remind Dr. Mortensen that Antedon among Crinoids and Amphiura among Ophiuroids can both eject their entire alimentary viscera and reduce themselves to a framework of arms with a nervous centre and yet regenerate all that is lost? Finally, in Dr. Mortensen's appeal to Dr. Bather, he forgets that what Dr. Bather objected to was my fathering of Dr. Mortensen's views on him. My friend Dr. Bather and I are in substantial agreement in our views on Echinoderms.

E. W. MACBRIDE.

Royal College of Science, South Kensington,
London, S.W.7, December 18.

DR. MORTENSEN (NATURE, December 16, p. 806) says that ". . . since the larvæ of the more primitive Asteroids (the Phanerozonia) are devoid of a Brachiolaria stage, the sucking disc . . . must be a later specialised structure. . . ." Surely the statement is an error, and (even if it were true) the conclusion unjustified. The Phanerozonia of Sladen includes eight families. One of these families, the Asteropectinidæ, contains species with non-attaching larvæ. Two other families (the Asterinidæ and the Gymnasteriidæ) have species with attaching larvæ (Asterina, *Q.J.M.S.*, 1896, and Porania, *Q.J.M.S.*, 1915). It is true that the Asterinidæ approach the Cryptozonia in some respects, but taken by itself this fact might rather lead us to look on the Asterinidæ as "primitive"—an annectant family between the two great orders of starfish. The Gymnasteriidæ are frankly Phanerozonate.

While Asteroid classification is admittedly perplexing, we are on fairly safe ground when dealing with the recognised families. At present it is known that members of five different starfish families (Gymnasteriidæ, Asterinidæ, Echinasteridæ, Solasteridæ, Asteriidæ) have attaching larvæ, while members of only one family (Asteropectinidæ) have larvæ without a sucker.

Dr. Mortensen's virtual narrowing down of Phanerozonia to Asteropectinidæ renders valueless his citations of Sladen, Ludwig, Hamann, and Gregory in support of the arguments in his letter. I yield to no one in appreciation of Dr. Mortensen's work, but even if the adult Asteropectinidæ were in some respects a primitive family (I believe the opposite), still to draw the conclusion which he says "inevitably" follows from this premise, in defiance of the direct data of comparative Asteroid ontogeny, not to speak of other considerations, would surely be one of those strangely naive misuses of the Recapitulation theory which have done much to obscure its essential truth.

JAMES F. GEMMILL.

University College, Dundee,
December 22.

Age and Area in Biology.

IN his recent book, "Age and Area," Dr. Willis gives (p. 114) the following: "Table showing in the horizontal lines the average number of vice-counties in Britain reached by the most widely distributed species in each genus of different sizes, and by the second, third, fourth, and fifth most widely distributed species."

	Average No. of vice-counties reached by the				
	1st sp.	2nd sp.	3rd sp.	4th sp.	5th sp.
Genus of over 10 sp.	108	104	96	86	79
6-10 sp.	103	84	64	49	33
5 sp.	98	76	39	22	16
4 sp.	89	61	35	13	..
3 sp.	89	48	27	..	..
2 sp.	73	33	..	..	..
1 sp.	50	..	..	..	..

Dr. Willis is convinced that the only explanation of the gradual diminution in average distribution from top to bottom of the table is that the average age of the species in the upper rows is greater and that they owe their wider distribution to their age. The gradation can, however, be explained without the help of either the principle of "Age and Area" or that of "Size and Space," as will become obvious if the method of constructing the table be considered. The average distribution of all the species in each of Dr. Willis's classes, in part obtained from the table above and in part from the London Catalogue, tenth edition, proves to be as follows:

No. of spp. in Genus	over 10	10-6	5	4	3	2	1
Average No. of vice-counties reached	40	48	50·25	49·5	54·6	53	50

The averages thus vary somewhat irregularly. In taking the average of the most widely distributed species in the first class, more than 90 per cent. of the lower numbers are rejected, in the second more than 84 per cent. are rejected, in the third class 80 per cent., in the fourth 75 per cent., in the fifth 66 per cent., in the sixth 50 per cent., and in the seventh none at all. Naturally this changes an approximately equal set of numbers into a falling series.

It is now possible to deduce the converse of Dr. Willis's theorem; for by reversing his process and rejecting the higher numbers it can be shown that the age of the "youngest" species decreases with the size of the genus.

The average distribution in vice-counties of the *least* widely distributed species in each genus according to size of genus, in part from Dr. Willis's table and in part from the London Catalogue, is as follows:

No. of spp. in Genus	over 10	10-6	5	4	3	2	1
Average No. of vice-counties reached	3	5·4	16	13	27	33	50

The regularity continues for the next "youngest" species, as can be seen from the original table. In neither case would the regularity suffer if the vice-comital numbers were redistributed to the species by any random method, for the chance of a genus receiving both a very high and a very low number would increase proportionately with its size.

W. C. F. NEWTON.

The John Innes Horticultural Institution,
Merton, October 31.

Soaring Flight and the "Olfactory" Organs of Birds.

THE note on page 784 of NATURE, December 9, misses the point of the theory I wish to be tested. The theory is that the well-developed "olfactory" nerves and apparatus of those birds which are capable of soaring flight has the function, not of smell, but of a delicate tactile sense whereby the bird is able to detect and take instant advantage of those upward air currents which recent experiments with gliding machines have shown to be so important in soaring flight.

It has been shown by Darwin and others that vultures do not smell with their well-developed olfactory apparatus. The experiments referred to in NATURE of December 9 show that this nervous apparatus is not necessary to give the bird its homeward direction or to enable it to indulge in flapping flight. So well-developed an apparatus is almost sure to have some function. It is obvious that soaring birds are in constant need of a means to detect the direction and strength of wind currents, especially those in an upward direction, and to adjust their balance and their wings accordingly. When soaring, the eyes and bill of the bird are directed downwards and the mucosa of the nostrils is exposed to any upward currents of air. I think it very likely, therefore, that the well-developed "olfactory" apparatus of these birds is a mechanism for detecting the direction and quality of air currents, and that the central "olfactory" ganglia enable the requisite adjustments of balance and direction of wing and tail planes to be made. The fact that birds whose nostrils have been plugged have been able to fly home by flapping in no way contradicts this theory.

To test it, I suggest in the first place that the sensibility of the olfactory mucosa should be abolished by painting with a 20 per cent. cocaine solution; and then see if a bird such as a gull can balance and soar as well after painting as before. Plugging of the nostrils, or section of the nerves, can also be tried. The effect to look for is on the capacity for soaring and gliding flight, not of flapping flight.

W. E. M'Kechnie.

17 Chepstow Place, London, W.2, December 15.

Nature Study and Phenology.

Phenology is the name given to that branch of meteorological science which has as its object the studied effect of weather conditions upon the seasonal development of animal and plant life.

From the late seventies of last century, and since 1891 on a uniform systematic plan, the Royal Meteorological Society has issued an annual report on phenology. This report, by collating and co-ordinating the work of a number of observers—mostly amateurs—in the British Isles, is able to present in summary form, supplemented by tables and maps, information of a most valuable botanical, ornithological, and agricultural nature.

Nevertheless, to accomplish such results, all that its observers are required to do is to note carefully the first appearance of certain birds and insects, twelve in number, and the first blooming of fourteen common plants. Other migrants and notes are asked for, but these are of secondary importance.

Here is a work which should surely appeal to the Nature-lover. By simply recording a few observations on a prescribed form, and forwarding the same promptly about November 15 (the close of the phenological year) to the Royal Meteorological Society, 49 Cromwell Road, S.W.7, the work of the amateur is lifted from a purely local value to become a real link in the progress of scientific research.

Stations are still urgently needed in many parts of our islands, and a copy of our observing form will be forwarded upon application to the office of the Society, or to one of us.

J. E. Clark,
41 Downscourt Road, Purley, Surrey.
I. D. Margary,
Chartham Park, East Grinstead, Sussex.

Water Snails and Liver Flukes.

In connexion with the letter on the above subject in Nature of November 25, p. 701, I should like to ask Dr. Monica Taylor if she has actual proof of sheep coming into contact with *Limnæa peregra*? The habitat of this species is so much more "watery" than that normally chosen by *L. truncatula* that it seems very doubtful if sheep could eat it with their food. Again, *L. truncatula* is such a widely distributed species that it seems difficult to believe that it is either rare in or absent from any district in which damp sedgy pastures are to be met with.

Planks left undisturbed for a few weeks, or cut rushes shaken over a newspaper after having lain on the ground for a time, might reveal the presence of *L. truncatula* in many places from which it was apparently absent. And what of *L. palustris*, the habits of which are often nearer to those of *L. truncatula* than *L. peregra*?

A. W. Stelfox.

National Museum, Dublin, December 12.

Reference to "The Life-History of the Liver Fluke," by A. P. Thomas (Q.J.M.S., 23, 1883), or indeed to almost any text-book in zoology, will show Mr. Stelfox that in order to become infected it is not necessary for sheep to eat the intermediate snail host of *Fasciola hepatica*. It suffices that the encysted cercariæ be swallowed. The latter may be found at considerable distances from their snail host, for the tailed cercariæ which give rise to the encysted forms exist as such for about a week after they have escaped from the host and are extremely active. On account of their microscopic character (they are just visible to the naked eye as snowy specks) the merest trace of water suffices for their needs. The more "watery" habitat of *L. peregra*, which is extremely common in all sorts of ditches, puddles, and streams, constitutes no impediment, therefore, to this snail acting as a disseminator of the liver-rot parasite granted that it can become properly infected. That it is capable of being infected and of setting free perfectly developed cercariæ I have abundant evidence.

In answer to my request for literature references to any host other than *L. truncatula* of the liver-rot parasite, Dr. Paul Pelseneer has kindly given me several, one of which (Lutz, *Centralbl. f. Bakteriol. und Parasitenk.*, xi. pp. 781-796, 1892), since it refers to *L. peregra* as an intermediate host of *Fasciola hepatica*, may be of use to Mr. Stelfox. With regard to the first of the methods of discovering *L. truncatula* suggested by Mr. Stelfox, I have had negative results in some districts although the sheep in these same districts are infected.

Monica Taylor.

Notre Dame, Dowanhill, Glasgow, December 16.

Effect of Moonlight on the Germination of Seeds.

During the summer of 1921 I investigated the effect of moonlight on the germination of seeds, and the results seemed to indicate a greatly increased velocity of germination. In order to determine whether this might be due to the effect of the moonlight on the diastase, a small quantity of mustard seed was crushed, and weighed quantities, after mixing with known amounts of water, were exposed to moonlight in Petrie dishes, controls set alongside being covered. Estimation with Fehling's solution of the sugar produced showed that there was an increased yield of about 15 per cent. caused by the moonlight.

A possible explanation of these results is to be found in the fact that at certain periods moonlight is plane-polarised, and in order to test this suggestion the experiments with crushed mustard seed were repeated with daylight after polarisation, either by reflection or by a Nicol prism. Control experiments were also carried out both in darkness and in ordinary daylight. The temperature was the same for all three experiments in each case and lay between 10° and 18°. A remarkable increase in the amount of hydrolysis was always noted when polarised light was used. Similar results were obtained with fresh oats, wheat, and cornflour, to which diastase had been added.

The investigation of this phenomenon is now being continued at Liverpool in conjunction with Prof. E. C. C. Baly and Prof. J. McLean Thompson, and the results already obtained are worthy of record since they give strong support. Diastase is added to a suspension of freshly prepared starch and the mixture well shaken. A drop of the mixture is placed on three slides under microscopes, one being exposed to polarised light, one to ordinary light, the third being kept in darkness. After thirty to sixty minutes, depending on the strength of the diastase, rapid hydrolysis can be seen to take place on the slides exposed to polarised light, while in the two controls the starch granules remain almost intact for some hours. By the use of a delicate thermocouple, the temperature was proved to be the same in all three cases. When the light is intense, the starch granules in the case of the polarised light break down entirely to little masses of dextrin and crystals of sugar which give deposits of cuprous oxide on warming with Fehling's solution. These results have been obtained with potato starch and the endosperm of maize and of wheat, the latter without the addition of diastase if freshly prepared.

In view of the suggestiveness of these observations the investigation is now being extended in various directions, and I hope to communicate the results in due course. ELIZABETH SIDNEY SEMMENS.

Chemical Laboratories,
University of Liverpool,
December 16.

Medical Education.

REFERRING to my letter (NATURE, December 9, p. 769), Prof. Dakin writes (NATURE, December 23, p. 845): "I am not quite clear whether this question has been propounded to invite answers, or to introduce another of Sir Archdall Reid's favourite discussions on mutations and fluctuations, etc." Prof. Dakin may rest assured that I do not invite a discussion about mutations and fluctuations. To be frank, I do not think such a discussion, conducted on purely scholastic lines, out of touch with reality, would be profitable. My object was simply to protest against the waste of time to which, as I supposed and still suppose, unhappy medical students are compelled. Here are some truths, none of which, I think, Prof. Dakin will deny categorically, but all of which, in practice if not in theory, are repudiated by many teachers of biology.

(1) Every relevant and verifiable fact, no matter how observed, is equal before science. Experiment is only one way—a very good way when need arises—of observing. The vast majority of authentic facts about living beings is derived from direct observation. People who limit their data to facts derived from experiment, or any other mode of observing, are, like those who insist on purely Christian, Mahomedan, or Hindoo testimony, merely sectarian. Dwelling in an islet of evidence they ignore the continent of truth which lies at hand.

(2) Our powers of observing are proportionate to our familiarity with the objects of study. Thus we can scarcely differentiate between peas in a pod or sheep in a flock; to an Englishman newly arrived in China all the natives seem much alike; but among our own kind, whom we study from birth to death, especially among our intimates, we see differences of every shade (*i.e.* fluctuations) between vital and enormous extremes—as, for example, in powers of resisting disease. Obviously, the experimenter who works among plants and lower animals knows nothing about fluctuations, and less than he ought to know about mutations. Lacking the necessary powers of observation, he merely guesses. That he guesses wrongly was abundantly demonstrated by my letter.

Can Prof. Dakin deny (*a*) that men, the only living beings minutely observable, are subject to stringent natural selection, (*b*) that this selection occurs amid fluctuations, (*c*) that evolution, proportionate to the length and severity of the selection, has resulted, (*d*) that human races never differentiate while there is interbreeding, but differentiate rapidly and invariably when separated by time and space, (*e*) that human races blend perfectly when crossed except in traits linked with sex, (*f*) that in spite of multitudinous human racial differentiations, there has never yet been recorded a useful human mutation, or one that changed the type of a race, (*g*) that human mutations (*e.g.* club-feet, idiocy, albinism) are not *inherited* independently, but are only *reproduced* independently, and (*h*) that lost ancestral traits never appear among natural varieties, but frequently among artificial varieties, even when purely bred.

Unless a biologist is able (1) to accept the foregoing propositions, or (2) to disprove them, or (3) to demonstrate that man is outside the scheme of Nature, he is not competent to teach biology to medical students; for, after these students leave him, they will observe for themselves, and be taught by men who have observed, with a minuteness and accuracy impossible to workers among plants and lower animals, and the things they then learn will be directly contrary to the teachings of the biologist.

I have before me the synopsis of instruction in biology of the Royal Colleges of Physicians and Surgeons. I must admit that it is a vast improvement, chiefly by way of elimination, of the rubbish (for a medical man) that I was taught as a student and which I supposed was still taught. The syllabus for 1923 will be even shorter and better. Biology, which should make doctors, in their vast numbers, the most potent scientific influence in the community, is disappearing from the curriculum. But I observe that the student must still learn the general structure of the Hydra and Lumbricus, the general structure and elementary physiology of Scyllium and Rana, and the elementary facts of evolution, heredity, and variation. But of what use, as taught by biologists, can these subjects be to the medical student? What, for example, will he learn about evolution, heredity, and variation? Will he learn that some characters are "innate," and the rest "acquired"? Recently I spent eighteen months trying to find out what biologists meant by these words and none could tell. Will he learn from a Lamarckian teacher that acquired characters are inherited, or from a neo-Darwinian that they are not? I spent a like period in trying to find out what was meant by "inherited," and failed again. Will he learn from a Darwinian that fluctuations furnish the materials for evolution? Or from a Mutationist that only mutations do so? Or will he be presented with such statements as the following: "The standard deviation of a coefficient of correlation computed from data derived from classes, members of which are mutually correlated, with special reference to the case of fraternal and parental correlations calculated from entries of siblings"? Will any biologist tell him that every character is a product of the combined action of nature and nurture (that is, is equally innate and acquired), that the human being is of such a nature that he is especially responsive to the nurture of use, and that this peculiarity bestows on man his position in the scale of life and has made him the educable and therefore, according to the teaching he receives, the rational animal—able to learn, for example, sense or nonsense concerning biology.

G. ARCHDALL REID.

9 Victoria Rd. South,
Southsea, Hants.
December 26.

Breeding Places and Migrations of the Eel.

By Dr. JOHS. SCHMIDT, Copenhagen.

IN an article in NATURE ten years ago (August 22, 1912, p. 633) I gave a review of the position at that time of the question of the breeding grounds of the freshwater eel (*Anguilla vulgaris*). We had then been working for seven or eight years upon the question, and it was our intention to pursue the work further by means of investigations extending across the Atlantic.

In the ten years then following falls the period of the Great War. This rendered work at sea impossible. We managed, however, partly before and partly after the war, to carry out an investigation covering the greater part of the northern temperate waters of the Atlantic, and the question, Where does the eel breed? can now, in the main, be considered solved. At the same time, we have ascertained the duration and extent of the migrations of the eel-fry.

The previous investigations had been undertaken with the well-equipped research vessel *Thor*, but its radius of action would not suffice for transatlantic cruises. From 1913 until 1921, when the Danish Government acquired the mine-sweeper *Dana* to replace the *Thor*, we were obliged to make our investigations from ships without any special equipment for marine research, partly from various trading ships plying on transatlantic routes, and partly from two schooners kindly placed at our disposal by the owners (1913–1914, the *Margrethe*, 90 tons; 1920–21, the *Dana*, 550 tons).

I shall in the following give a brief survey of the discoveries made regarding the breeding places of the eel since my article in NATURE in 1912, adding also some remarks on the immigration of the eel-fry to Europe. For further details I must refer any readers interested to my recently published paper in the Philosophical Transactions.[1]

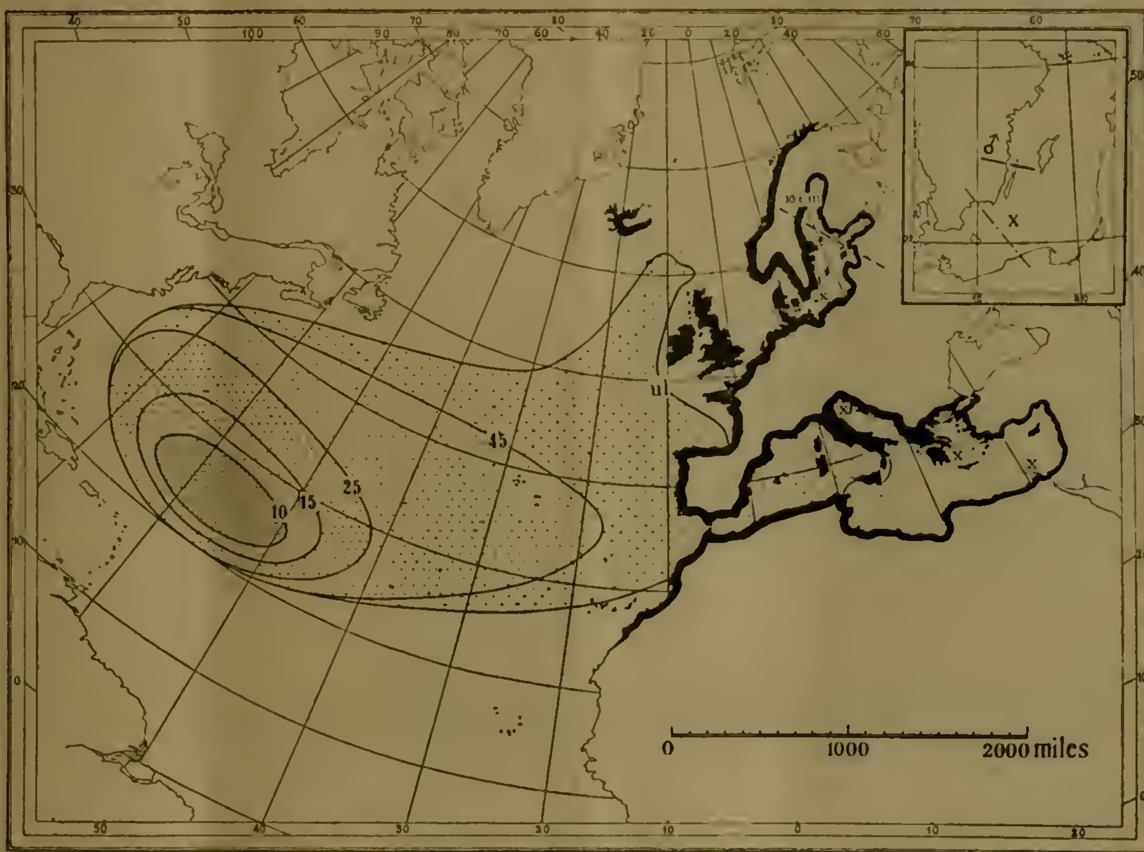

FIG. 1.—European eel (*Anguilla vulgaris*). *Spawning places* (bounded by innermost 10 mm. curve); *distribution of larvæ* (dotted area) and of *adults* (black strip along the coasts where the eel occurs).

The curves show limits of occurrence; *i.e.* larvæ less than 25 mm. have only been found inside the 25 mm. curve, etc. The outermost curve denotes the limit of occurrence of unmetamorphosed larvæ (*ul*), ♂ and 30 cm. (in the Baltic) of male eels and of eels less than 30 cm. in length. X: easternmost records of unpigmented elvers (Baltic and Mediterranean).

In my article in NATURE (August 22, 1912, p. 633) I summed up the position as follows: "We cannot say as yet where exactly the spawning takes place, and but little more than that the spawning places must lie in the Atlantic beyond the Continental Slope, and that they must be in the Northern Atlantic."

The smallest (youngest) developmental stage of the eel then known to us was a larva of 34 mm. length. In order to say anything definite as to where in the

[1] Philosophical Transactions of the Royal Society of London, Series B. No. 385, vol. 211, pp. 179-208, 1922.

Atlantic our eels did breed, we had to find far younger stages, for a larva so large as 34 mm. might well be imagined to have moved a great distance from the spot where it came into the world. Nor was it enough to find a few isolated specimens of the youngest stages; a spot which could be declared to be the site where the

FIG. 2.—Sizes of eel larvæ (*Anguilla vulgaris*) caught in a single haul of two hours' duration at *Dana* Station 871 (lat. 27° 15′ N., long. 61° 35′ W.) in the western Atlantic, June 27, 1920, depth about 50 metres. About 800 specimens of O-group and 1 of I-group are shown. A II-group specimen, length 74 mm., from the eastern Atlantic, is shown for comparison. Reduced to about one-quarter (see the centimetre-scale).

great hosts of eels from the European continent assemble for their spawning must necessarily yield earliest stages of the offspring in great numbers.

The task before us, then, was to chart the distribution of the various developmental stages of eel-larvæ, from the oldest, about $7\frac{1}{2}$ cm. long—which we knew from previous investigations were to be found off the coasts of Western Europe and in the Mediterranean—to the earliest tiny stages which no one as yet had ever seen. If we could ascertain where, and at what seasons, these tiny larvæ were found, then we should at the same time have discovered *where* and *when* the eels spawn. Once it was known where the various sizes (age-groups) of growing larvæ occurred, it would be possible to form an idea as to the extent and duration of the migrations of the eel-fry from the breeding grounds to the fresh waters of Europe.

These years of research have been rich in excitement and suspense; disappointment alternating with encouraging discoveries, and periods of rapid progress with others during which the solution of the problem seemed wrapped in deeper darkness than ever. One is tempted to describe the investigations in their chronological sequence, from first to last, in order to show how by slow degrees, advancing step by step, we came to see great parts of the life-history of the eel emerge from the darkness that surrounded it. The question of space, however, precludes this. We must content ourselves with setting forth the facts as they now appear, after eighteen years of work, and seeing what conclusions may be drawn from them.

. . . . . .

The chart Fig. 1 gives us the main sum of these many years' investigations into the distribution of the eel larvæ. This may be briefly stated as follows: The larvæ of our European eel (*Anguilla vulgaris*) are found distributed across the whole of the Atlantic Ocean from off the coasts of Europe to those of the United States. They increase in number, but decrease in size, as we pass from the European side towards America. The curves on the chart show that the spawning grounds comprise a restricted area in the western Atlantic, north-east and north of the West Indies, between 65° and 48° long., for here—*and here only*—are the youngest, newly hatched larvæ found. The eel spawns at the close of the winter and during spring. In April the larvæ had an average length of 12–13 mm., in June 25, and in October 35–40 mm. During their first summer the larvæ are found only in the western Atlantic. Enormous quantities of these first-year larvæ (the O-group, as we call them) are found at this season west of 50° W. long. In June 1920, when we were working there with the schooner *Dana*, it was impossible to draw a net through the upper water layers without bringing them up in quantities, and we often took several hundred specimens at one haul, as shown in the illustration Fig. 2.

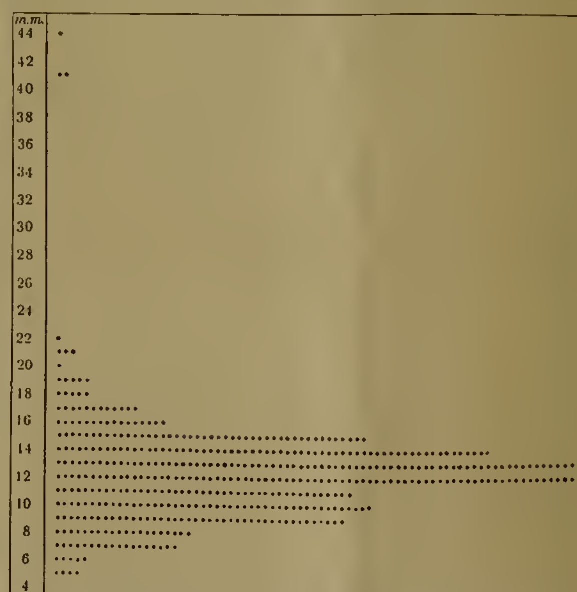

FIG. 3.—European eel (*Anguilla vulgaris*); western Atlantic (west of 50° long. W.), *Dana* Stations 935-948, April 1921; O-group and 3 specimens of I-group.

We are therefore excellently acquainted with the sizes and growth of the O-group larvæ. In June 1920 the four or five thousand specimens taken varied from 7 to 37 mm. in length, with an average of 25 mm.

In the course of the autumn and winter, the great bulk of the first-year larvæ (the O-group) disappears from the spawning grounds in the western Atlantic, but a number of stragglers remain there throughout the winter, appearing in the following spring as a I-group, sharply distinguished in point of size from the young fry of the O-group which have come into being mean-

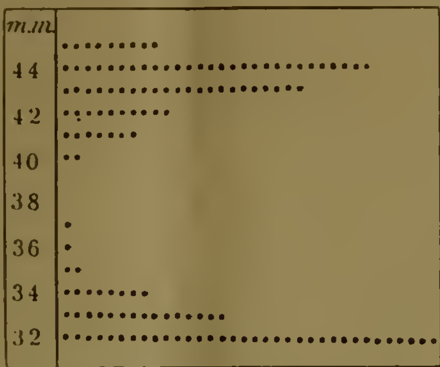

FIG. 4. European eel (*Anguilla vulgaris*); western Atlantic (west of 50° long. W.), *Dana*, June 1920. Showing limit between O-group and I-group.

time (see Figs. 3 and 4). These specimens of the I-group, however, found in early summer west of 50° W. long., are comparatively few. The great majority, now measuring 50-60 mm., have, in the course of the winter, moved north-east and east, and are now in the central Atlantic, about as far as the longitude of the Azores, or even some distance farther east. In the following year again, by early summer, these larvæ have attained their full size, averaging about 75 mm., and appear now, as a II-group, off the western shores of Europe and far up in the Mediterranean, having, in the latter case, passed in through the Straits of Gibraltar during the winter, or in the autumn.

The retrograde metamorphosis of the full-grown larvæ takes place in the course of the autumn and winter. In the process, they become elvers, and in spring, being then three years old (the III-group) move up into fresh water, when the temperature of the latter permits. At this stage of development they resemble miniature eels (Fig. 5). The average length is about 65 mm., but they have lost greatly in dimensions and weight during metamorphosis, running no fewer than 1500 specimens to the pound. In England, it is more especially on the west coast, in the Bristol Channel, that the elvers ascend in very great quantities during the spring, the phenomenon being generally known among the inhabitants, who catch them for human consumption, or even for feeding pigs. The name "elver," too, comes from this part of the country. There are interesting accounts from Gloucester telling how, in March and April, fishermen stand in hundreds along the river banks, each with a hand net, fishing for elvers, and often making astonishingly large catches—a hundredweight of fish per man in one night. Bearing in mind the fact that 1500 elvers go to the pound weight, it will be realised that enormous quantities of eel fry must come in every year to the coasts of Europe from the Atlantic, numbers answering well to the great masses of tiny larvæ we found with the *Dana* on the breeding grounds of the eel in the western Atlantic. In 1920, 1921 and 1922, we found first-year larvæ (O-group) of the respective years on those grounds, but at this present time of writing (October 1922), none of these will yet have reached their destination, the fresh waters of Europe. Not until next spring (1923) will the fishermen of the Bristol Channel be able to catch elvers of the 1920 stock, which appeared in our nets in the western Atlantic in June 1920, and are shown in Fig. 2. And not until 2½ years from now—that is to say, in the spring of 1925—will the 1922-year class, specimens of which were taken by the *Dana* expedition about six months ago (April and May 1922) near Bermuda, make their entry into the Severn.

Moving eastward, then, across the Atlantic, the eel fry come to the shores of Europe, and it is natural that here they should be found in greatest numbers. It is here also, that the capture of them has developed into an actual industry, as for example, apart from the Bristol Channel, also at several places in the south-west of Ireland, but especially on the west coast of France and the northern shores of Spain.[2] They are taken here

FIG. 5.—European eel (*Anguilla vulgaris*); showing the size of the four youngest year-classes (O-, I-, II-, and III-groups) in June; slightly enlarged: the top specimen measures 25 mm. in length.

in tons, and the inhabitants have special names for them (*civelles* or *pibales* in France, and *angúlas* in Spain).

It must not be imagined, however, that all the eel fry coming from the Atlantic will be stopped by the west coasts of Europe. Great numbers of them continue

[2] Also at some places in the western Mediterranean on the west coast of Italy, the elver fishery reaches the status of an industry in itself.

on their way—living semi-pelagically—to the eastward, until the metamorphosis is completed, and the small eel young have acquired a dark covering of pigment. In Northern Europe they move—by way of the Channel and round the north of Scotland—through into the North Sea and farther, *via* the Danish waters, to the western parts of the Baltic, where they have been found so far east as E. of Bornholm, at stages where the metamorphosis was not yet quite completed (Dr. A. C. Johansen, with the *Thor*), Fig. 1. In the northern parts of the Baltic, elvers are not known, or indeed any eels less than 20-30 cm., though the eel occurs right in to the innermost waters of that sea. The eels found in Finland are large females, and on the east coast of Sweden no males have been found north of lat. 57° 08′ (off Öland); see Fig. 1. This peculiar fact evidently answers to what we know from the great rivers, where the female eels generally move farther up into the higher reaches than the males.

The eel fry enter the Mediterranean at an early stage, as unmetamorphosed larvæ, most often not even having attained their full larval size, between one and a half and two years old. As unmetamorphosed larvæ they are found throughout the western basin, west of Italy, and at times, perhaps, still farther to the eastward. Even in the most easterly parts of the Mediterranean, an ascent of elvers takes place, these being transparent, and thus not having fully completed their metamorphosis. I have in this connexion received some information, with samples, from Mr. Geoffrey W. Paget, Director of Fisheries Investigations in Cairo. At a pumping station near Alexandria, where fresh water is pumped in large quantities into a channel leading direct to the sea, Mr. Paget found, on February 24, 1920, "that elvers were present in prodigious quantities, being unable to proceed further on account of the station. From this date—February 24—until April 15, fishing was practically continuous, and we transported over 5,000,000 elvers to the canal systems inland." Mr. Paget's observations are highly interesting, showing as they do that elvers which have not yet completed their metamorphosis can occur in such great quantities so far east as about 30° E. long. Together with observations from northern Europe, they give us a clear picture of the remarkable power of migration possessed by the eel fry. From the breeding grounds in the western Atlantic to the mouth of the Nile is a distance approaching 90 degrees of longitude, or one-fourth of the earth's circumference, and this distance is covered by the eel fry in the space of about three years. They may reach the Nile and the western Baltic before their metamorphosis is yet complete, and the greater part of the journey is made while they are still in the leaf-shaped larval stage. No other instance is known among fishes of a species requiring a quarter of the circumference of the globe to complete its life history, and larval migrations of such extent and duration as those of the eel are altogether unique in the animal kingdom.

Theories of Magnetism.

By Dr. A. E. OXLEY.

MUCH attention has been devoted in recent years to theories of magnetism, and an interesting survey of the position of the subject is given in the report of a committee of the U.S. National Research Council issued by the National Academy of Sciences, Washington, in August last (vol. 3, part 3). It is difficult in a descriptive article of moderate length to present judicially the various views which have been advanced, but an attempt will here be made to do this, using the report referred to as a basis, and supplementing it with accounts of one or two advances not recorded therein.

Poisson in 1820 published a mathematical theory of magnetism which was based on Coulomb's inverse square law. He merely regarded magnetic substances as possessing positive and negative magnetic fluids which could be separated by the application of an external magnetic field resulting in the production of the magnetic effects as observed in bar magnets. This theory was eventually (1831) shown to be untenable by Faraday's discovery of the phenomenon of diamagnetism.

Ampère's theory (1825), based on Oersted's discovery (1820) of the magnetic effects of an electric current, may be regarded as the foundation of modern magnetic theories, though at that time the laws of electromagnetic induction were unknown. This theory led Weber (1854) to develop a theory which aimed at an explanation of the magnetic effects of bar magnets on the assumption that the molecules were *always* equivalent to miniature magnets, whether the substance were magnetised or not, the action of the external field being merely to align the miniature magnets along the direction of the applied field. No explanation of the phenomenon of hysteresis was given, however, until Maxwell ("Electricity and Magnetism," § 444) extended Weber's views and interpreted the more complicated hysteresis effects in terms of certain quasi-elastic forces.

The theory of Ewing (1890) enabled us to visualise the nature of these hypothetical controlling forces by attributing the sluggishness of the response to an applied field as due to the interaction between special groups of molecules. This gave a rough explanation of hysteresis effects in terms of the mutual actions between complex groups of molecular magnets, and accounted for the shape of the hysteresis loops, the coercive force and the retentivity of a ferro-magnetic substance like iron.

At the beginning of the present century, attempts were made by Voigt and J. J. Thomson to outline an electron theory of magnetism based on the magnetic effects of a moving electron, but it was not until the theory of paramagnetism and diamagnetism of Langevin appeared (1905) that a satisfactory interpretation of these phenomena was presented.

The classical researches of Curie (1895) had shown that substances could be divided into three groups as regards their magnetic properties under an external field. These are, (1) diamagnetic substances, which show a minute negative induced moment, practically independent of temperature; (2) paramagnetic substances, which show generally a larger and positive induced moment, varying inversely as the absolute temperature, and (3) ferro-magnetic substances, which show still larger positive magnetic moments, which vary with the temperature and external field in a complex way. In each case the total induced moment per gram of the substance, divided by the applied field, is called the specific susceptibility. On Langevin's theory, a molecule consists of a congeries of revolving positive and negative charges; if the total initial magnetic moment of these is zero, the substance is diamagnetic, if it is not zero, the substance is either paramagnetic or ferro-magnetic. The diamagnetic effect must exist in all matter, but is masked by the larger para- or ferro-magnetic effects in the latter case. Langevin's theory indicated that when there is no interaction between the molecules, the diamagnetic effect is independent of temperature, while the paramagnetic effect varies inversely as the absolute temperature in accordance with the Curie rules mentioned above. Langevin did not consider ferro-magnetism; this was done by Weiss.

These remarks hold only in so far as there is no appreciable mutual action between the molecules. In ferro-magnetic substances, such action is pronounced, and Weiss (1907) extended Langevin's theory by introducing an intrinsic molecular field to represent this mutual molecular interference. According to Weiss the molecular field has not necessarily a magnetic origin; it corresponds to the forces determining crystallisation, but for magnetic purposes it may be regarded as a magnetic field proportional to the intensity of magnetisation, and its value is then of the order 10^7 gauss. Weiss further showed that the energy of this field is a measure of the thermal change when, at the critical temperature, the substance passes from the ferro-magnetic to the paramagnetic state. The results obtained with magnetite above the critical temperature showed that Curie's rule of paramagnetism held but that the constant of proportionality had a series of different values over certain temperature ranges. These values were interpreted by Weiss as due to sudden changes of the molecular magnetic moment by a unit, the value of which was found to be $16{\cdot}4 \times 10^{-22}$ c.g.s.e.m.u. This is the Weiss magneton; its value has later been corrected to $18{\cdot}54 \times 10^{-22}$. Weiss and others claim that this unit exists in many ferro-magnetic substances and in paramagnetic salts, though in the latter substances the evidence is not quite so conclusive. Further practical and theoretical extensions of the work have been made by Weiss, Kunz, Honda, and Frivold, but lack of space prevents an extended account of these here.

Honda (1910) made an extensive examination of the variation of susceptibility of many elements with temperature, and concluded that, in general, the Curie rules did not hold. In 1914 he submitted that the magnetic moments of molecules were not constant but depended on the temperature, and that they exert forces on one another which hinder their lining up parallel to the field. In solids which are paramagnetic, the magnetic unit is a spherical group of molecules. This sphere becomes elongated in the ferromagnetic state. A second theory due to Honda (1914) advocates a gyroscopic motion of the molecule to account for diamagnetism and paramagnetism. This is very similar to the theories of Gans (1910–1916). There appears to be no doubt that certain gyroscopic motions are involved, but more recent evidence (see below) indicates that these do not arise from *molecular* rotations but from a gyroscopic property of the *electron* itself, i.e., *the electron is a magneton*.

Certain departures from the Curie rules for paramagnetic crystals at low temperatures have been examined by Onnes, Oosterhuis, and others, and interpreted in terms of a molecular field in a manner similar to that of Weiss.

The variation of diamagnetism accompanying the transition from the liquid to the crystalline state has been investigated by the writer (1911–22), who found that organic compounds changed their specific susceptibility by a few per cent. The theoretical explanation of the results was obtained by including in the Langevin theory of diamagnetism a term depending on the *local* polarisation which determines a *local* molecular field. Weiss regarded his molecular field as uniform, but in the present case it must be of an alternating character as we pass from molecule to molecule of the crystal. It exists whether the substance is subjected to an external field or not, and distorts the electron orbits, producing a few per cent. change of specific susceptibility on crystallisation. It can be shown that (1) these local fields are of the same order of intensity as Weiss's field, namely, 10^7 gauss, (2) the energy of this field is a measure of the latent heat of fusion, (3) the existence of such a field would induce a magnetic double refraction which is comparable with the natural double refraction of crystals, (4) the change of volume on crystallisation is the magneto-striction effect of this molecular field, and (5) the energy of the local molecular field per unit volume represents the tensile strength of the crystal.

Thus it appears that in all crystalline media there are intense local fields, the linking up of which from molecule to molecule determines the rigidity of the crystal. We are not certain what is the true nature of the field; it is probably partly electrostatic and partly magnetic. That the magnetic forces are important in determining the distribution of the planes of cleavage in crystals has been emphasised by the writer (1920), a *uniform* magnetic field being capable of isolating the cleavages, *i.e.*, of distinguishing between an open or close packing of the molecules in certain directions.

The present position of magnetic theories is fascinating. There appears to be evidence that the ultimate magnetic particle is neither the molecule nor the atom but the electron itself; in other words, the electron is not merely an electrostatic charge but also a magnetic doublet or magneton. Such a structure no doubt accounts for the spiral tracks of the β-particles as observed by C. T. R. Wilson. The problem of the interaction between such doublets in crystalline media is far from being solved. It appears that a useful picture of the mechanism is obtained on the Lewis-Langmuir theory (elaborated by Langmuir in 1919) of the cubical atom. In non-ionised media the coupling force between atoms is formed by units, each consisting of a pair of electrons, and each pair corresponds to a single valency bond of chemistry. The influence of magnetic forces in determining crystalline structure, magne-crystallic action, and chemical combination in non-ionised media is apparent. It is interesting to note that Pascal (1910) showed that in organic compounds, all of which are diamagnetic, the molecular susceptibility is (apart from certain peculiarities of structure common to certain types of compounds) equal to the sum of the atomic susceptibilities of the component atoms. This is not true of ionised compounds, such as metallic salts, where the coupling between the atoms is probably of an electrostatic nature.

Further developments of the magneton theory were made by Parson (1915), who identified the electromagnetic coupling between pairs of magnetic doublets with the force of chemical combination. The magneton, or anchor ring electron, has been applied by Allen (1920) to interpret the phenomena of optical activity and optical isomerism. In connexion with the magnitude of the local magnetic field, namely, 10^7 gauss, it is interesting to note that Allen's calculations give a value 10^8 gauss at a distance from the anchor ring equal to its radius.

A number of attempts to obtain a quantum theory of magnetism have been made in recent years by Oosterhuis, Keesom, Gans, Reiche, and others. These are based on the assumption that the molecules are endowed with quantised molecular rotations, but the theory of Gans is the only one to take account of molecular interactions.

In connexion with these views the theory of Bohr and Sommerfeld must be considered. Though this has proved so successful in the interpretation of the fine structure of spectral lines, it does not appear at all obvious how the open elliptical orbits of this theory can give the uniquely balanced systems required to explain diamagnetism, nor does it give a picture of the directed forces which are responsible for crystal lattices. These considerations suggest that the atom must have a static structure. Perhaps the electron itself is quantised, the motion of its parts being highly localised compared with atomic dimensions. The electrons in an atom may be distributed on spherical or ellipsoidal surfaces, and the passage from one surface to another determine the emission of a definite amount of radiation of a certain frequency.

Quite recently Whittaker (1922) has published a new quantum mechanism of the atom based upon the existence of a number of atomic magnetic doublets. If an electron collides with this system the collision is perfectly elastic if the velocity of the electron is less than a certain amount. If the velocity exceeds this amount the electron passes through the magnetic system and hands over to the latter a definite quantum of energy which is identified as Planck's quantum. The derivation of the Balmer series can be obtained from this conception; it may later be found equally effective in interpreting the fine structure of spectral lines. Allen has replaced the particular magnetic structure postulated by Whittaker by a pair of ring electrons, thus identifying Whittaker's model more closely with Langmuir's cubical atom. The atomic structure is dynamical locally but is essentially static at ranges comparable with molecular dimensions. The static structure is required to account for crystalline and magnetic properties of matter in the non-radiating state. Recent experiments by the writer (1922) indicate that the occlusion of hydrogen by palladium produces a system the electronic configuration of which is similar to that of silver, and the fall in paramagnetism of the palladium is consistent with this view, silver being diamagnetic. Manganese which has been fused in an atmosphere of hydrogen is ferro-magnetic, although pure manganese is paramagnetic. Iron which has been fused in hydrogen has a higher coercive force than ordinary iron (like cobalt). These experiments indicate that when hydrogen is occluded in one of these elements an electronic system is produced corresponding to an element the atomic number of which is one higher than that of the element occluding the hydrogen. The suggestion is that the hydrogen electron, in such systems, enters into the outer shell of electrons of the metallic atom.

A static model, consistent of course with a highly localised dynamical model, such as the one advocated above, seems to be the only satisfactory interpretation of these results.

Obituary.

Prof. Oscar Hertwig.

THE death of Oscar Hertwig, formerly professor of anatomy in the University of Berlin and director of its Anatomical-Biological Institute, removes from the scene one of the chief leaders in morphological science. He formed a link in that chain of illustrious men including Johannes Müller, Gegenbaur, Fürbringer, and Gaupp, which has demonstrated how fully Germany has realised the importance of entrusting its great chairs of anatomy to men who are anatomists in the broadest sense of the word, leaders in vertebrate morphology and not merely experts in the details of anthropotomy.

Hertwig was most widely known through his series of admirable text-books. His "Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbeltiere" made its appearance in 1886 and has passed through numerous editions, both in its extended and in its condensed form ("Elemente," 3rd Edition, 1920). "Die Zelle und die Gewebe," first published in 1893, and known in its later editions as the "Allgemeine Biologie," is still widely used as a most admirable text-book of general biology on a cytological basis. During the years 1901–6 Hertwig brought out the various instalments of that wonderful encyclopædia which bears the characteristically German title "Handbuch der Entwicklungslehre der Wirbeltiere," edited and in parts written by himself. While it is, perhaps, permissible to hope that the appearance of this colossal work marks the approaching end of what may be called the encyclopædic age of biology, in which real progress has become more and more impeded and slowed down by the accumulation of minute details, there can be no question regarding the value and utility of Hertwig's great "handbook."

Hertwig, a laboratory worker rather than a field naturalist, had no belief in "das schon morsch gewordene Lehrgebäude des Darwinismus," and to this fact we owe the last of his larger text-books—the useful and interesting, if not wholly convincing, "Das Werden der Organismen," first published in 1916 and now in its third edition.

Oscar Hertwig's really great, indeed epoch-making, contributions to the development of biological science are to be found, however, not in his text-books, but in a comparatively small group of original investigations, some of them carried out in co-operation with his brother Richard, which are of the most fundamental importance. It was in 1875 that Hertwig, forestalling van Beneden by a few months, showed for the first time, by his studies upon sea-urchin eggs, what was the real nature of the fertilisation of the animal egg—that the process consisted essentially of the fusion between the nucleus of the egg and the nucleus of one single spermatozoon. In 1878 there appeared the monograph by the brothers Hertwig upon the sense organs and nervous system of the medusæ—a work published before its time and perhaps destined to fill its rôle more completely in the future with a fuller recognition of the fact that the most fundamental function of the nervous system is to preserve intact the organic continuity in the animal body throughout its evolutionary increase in bulk.

In the early eighties of last century, Oscar and Richard Hertwig, stimulated by the work of English morphologists—Huxley, Lankester, and Balfour—turned themselves to the investigation of the foundations of the germ-layer theory, clearing up the muddle which had resulted from the non-recognition of what we now know by Hertwig's name, mesenchyme, and corroborating and amplifying Lankester's conception of the enterocœlic nature of the cœlom.

In 1890 Oscar Hertwig published his comparison of "Egg- and Sperm-formation in Ascaris," in which he worked out in minute detail the parallelism in gametogenesis in the two sexes, and cleared up the mystery of the "polar bodies," long known as characteristic of the unfertilised animal egg. Hertwig showed that male and female gametes are alike formed in sets of four, but that in the female sex three of each four degenerate, the three degenerate eggs being the polar bodies.

The last of Hertwig's works that demands mention is his study of those extraordinary malformations of vertebrate embryos to which he applied the name "spina bifida." In these the body of the embryo is divided into two halves by a longitudinal cleft traversing the notochord and the greater part of the central nervous system, and yet this seemingly irreparable injury proves no insuperable barrier to continued development. In many cases the cleft closes, the two halves unite and a perfectly normal individual results. Hertwig correlated these monstrosities with a hypothetical evolutionary stage in which the neural surface of the ancestral vertebrate was traversed by a slit-like primitive mouth, and to-day this is still the only working hypothesis at our disposal to explain a very extraordinary phenomenon.

It must not be imagined that Hertwig's activities were limited to such fields as are indicated by the various works to which allusion has been made. He interested himself in the social questions of the day, and the very last of his publications that has come into the writer's hands is "Der Staat als Organismus" (1922), with a trenchant criticism of some of those forms of extremism that are so rife at the present time.

Mr. A. Trevor-Battye.

Mr. A. Trevor-Battye, who died at Las Palmas on December 20, was an accomplished naturalist and Arctic traveller. The second son of the Rev. W. Wilberforce Battye, he was born in 1855 and adopted in 1890 the additional surname of Trevor on succeeding to certain estates that had fallen to his father. After leaving Oxford, Mr. Trevor-Battye indulged his taste for natural history in extensive travels in North America, Africa, the Himalayas, and Arctic Europe. In 1894, in the yacht *Saxon*, he visited the little known island of Kolguev, in the Barents Sea, with the object of devoting the summer to the study of its bird life. The *Saxon*, on returning from a cruise to Novaya Zemlya, missed Mr. Trevor-Battye through inability to reach the east coast, and returned to England without him or his companion, Mr. Hyland. The two Englishmen joined a party of wandering Samoyedes and made good their retreat to the mainland by sledge and boat. This was a fruitful expedition and completed the exploration of Kolguev.

In 1896 Mr. Trevor-Battye returned to the Arctic regions, accompanying Sir Martin Conway as naturalist on his expedition to Spitsbergen. Mr. Trevor-Battye made explorations around Dickson Bay and, with Prof. Garwood, climbed Hornsunds Tind. A few years later he visited Crete and made valuable contributions to the knowledge of its natural history.

Mr. Trevor-Battye was editor of natural history in the "Victoria History of the Counties of England," and of Lord Lilford's book on British birds. His own works included "Icebound on Kolguev" (1895); "A Northern Highway of the Tsar" (1897); and "Camping in Crete" (1913). "Crete: its scenery and natural features" was a recent contribution to the *Geographical Journal* (September 1919).

Dr. Fridolin Krasser.

A few weeks ago Dr. Fridolin Krasser was found dead in his laboratory at the Deutsche Technische Hochschule at Prague, where for several years he had occupied the chair of botany. He was widely known as a palæobotanist who had devoted himself to the investigation of Mesozoic floras, more especially to the study of the large collections of Upper Triassic plants from the well-known Lunz beds in the Hof Museum of Vienna. In 1887, Dr. Krasser published a note on heterophylly inspired by the work of Baron Ettingshausen, with whom he was closely associated. In 1891 he wrote on the Rhætic floras of Persia; a few years later he turned his attention to the Cretaceous plants of Moravia, and in 1900 and 1905 made some interesting contributions to our knowledge of Palæozoic and Mesozoic floras of the Far East.

Dr. Krasser published several papers on Upper Triassic floras, and it was hoped that he would eventually produce an adequately illustrated account of this important but still very imperfectly known period of botanical history. It would be a fitting recognition of the value of Dr. Krasser's work if the authorities of the Vienna Museum could see their way to entrust the material to which he was devoting his vacations to some palæo-botanical colleague with a view to the publication of a comprehensive memoir. Among other contributions reference may be made to papers on the genus Williamsonia and other Jurassic plants from Sardinia.

Dr. Krasser was a man of attractive personality, a good friend, and an enthusiastic investigator.

PROF. RHYS DAVIDS.

By the death on December 27, in the fulness of years and honour, of Prof. T. W. Rhys Davids, England has lost a great oriental scholar. Son of a Congregational pastor at Colchester, and born on May 12, 1843, Prof. Davids was educated at Brighton School, and studied Greek and Sanskrit at Breslau University. He spent eight years in the Ceylon Civil Service, where he mastered Pali and commenced his Buddhistic studies. Returning home he became, from 1882 to 1912, professor of Pali and Buddhist literature at University College, London, and from 1904 to 1915 professor of comparative religion at the University of Manchester. He was secretary and librarian of the Royal Asiatic Society from 1885 to 1904, and he shared in the foundation of the British Academy, of which he was a fellow.

Prof. and Mrs. Rhys Davids—the latter also an accomplished Pali scholar—were the leading agents in spreading a knowledge of Buddhism in this country. An inspiring teacher and an indefatigable worker, he produced a number of books on the subject which he had made his own; the best known of which are his manual of "Buddhism," "Buddhist India," and "American Lectures on Buddhism." He also did good work in establishing the Oriental Translations Fund and the Indian Text Series. His death leaves a gap in the scanty ranks of oriental scholars which will not be easily filled.

We regret to announce the death on December 30, in his sixty-sixth year, of Dr. J. B. Haycraft, emeritus professor of physiology in the University of Wales.

Current Topics and Events.

SCIENTIFIC workers are too well acquainted with the value placed on their services to be surprised at an advertisement for a university assistant lecturer in a department of science at a salary of 300*l.* a year. Recently, however, such an offer provoked an indignant protest from a disinterested member of the general public, who stated to us that the remuneration of his chauffeur was on a more liberal scale. While it is true that any educated man with aspirations would prefer a university teaching post, with its vague promise of an interesting and useful career, to the more mundane occupation, it is nevertheless a matter of the gravest concern that those educational institutions which are engaged in the task of increasing and disseminating knowledge are in such a parlous financial position that they are forced to offer salaries bearing no relation to the status of the posts, and imposing on their holders an unfair burden of financial sacrifice. The greatest benefactors of the universities are still the members of the teaching staffs themselves.

THE story of Shackleton's last Antarctic expedition on the *Quest*, as presented at the New Scala Theatre, is a little disappointing, inasmuch as considerable interesting material is not explained. It is a difficult task for Commander Frank Wild to supply anything more than a running commentary with so much film shown. The curtailment of some of the "Departure" film and "Ports of Call" film, such as a bull fight in Portugal, all of which occupy considerable time, would, perhaps, be advantageous, and the audience taken as quickly as possible to the lonely sub-Antarctic islands with their fascinating bird life—to South Georgia and its whaling industry, and to the southern ice fields. A few still pictures introduced here and there would afford the lecturer an opportunity of giving more information, which is badly needed, of the natural history pictures. The natural history films are extraordinarily interesting, and commence with a landing through the heavy surf on St. Paul's Rocks on the equator. In the midst of these small dangerous rocks there is a lagoon of wonderfully clear water, with many species of fish to be seen in its pellucid depths. The rocks provide a nesting place for hundreds of sea birds. Excellent films are shown of the rookeries of the great wanderer Albatross, the Cape hen, the giant petrel, the Gentoo penguin, and the sea elephant, all taken at South Georgia. Ascension Island provides a moving picture of a great rookery of terns. The lengthy film of the whaling industry in South Georgia is shown with the film running at high speed, commencing with the harpooning of the rorqual, or blue whale, and showing the whole process of "trying out." This film is full of interest and instruction, but, unhappily, bears eloquent testimony to the extermination of southern whales. Soon these rorquals and fin-back whales will become as scarce as the sperm and southern whalebone whale, if the industry is allowed to continue uncontrolled. Zavodovski Island, to the south of South Georgia, was next visited. This ice-covered, rock-bound, and forbidding island is the home of countless penguins. Round its coast are numbers of deep caves which belch forth dense sulphurous fumes. The three months spent in the ice pack with constant vigilance and toil in battling the floes, are not of special interest from a lecture point of view, though no doubt useful scientific data was collected.

THE duration record in gliding established at the recent contests on the South Downs has already been broken in a rather sensational manner, and by another

Frenchman, Lt. Thoret. The event took place at Biskra in Algeria on Wednesday, January 3, and Lt. Thoret stayed in the air more than seven hours, from 9.3 A.M. till 4.4 P.M. It is interesting to note that the flight was carried out on an ordinary aeroplane in which the power had been shut off completely, and not in a specially designed glider. The loading was 3·8 lb. per square foot instead of 2·2 lb. per square foot as in the specially constructed gliders used during the summer. The machine was a Hanriot 14 biplane, weighing 1364 lb. including a motor of 80 H.P.

APPLICATIONS are invited for the Theresa Seessel Research Fellowship of Yale University, value 300*l*., for the promotion of original research in biological studies. Preference will be given to candidates who have already obtained their doctorate, and demonstrated by their work their fitness to carry on successfully original research work of a high order. The holder must reside in New Haven during the college year, October to June. Applications, which should be accompanied by reprints of scientific publications and letters of recommendation, and a statement of the particular problem which the candidate expects to investigate, should be made to the Dean of the Graduate School, New Haven, Conn., before May 1 next.

A SPECIAL meeting of the Royal Society of Medicine will be held on Friday, January 26, at 8.30, to commemorate the centenary of the death of Edward Jenner. There will be an address by Sir W. Hale-White on "Jenner and his Work," and objects of historical interest will be shown.

THE Trueman Wood lecture of the Royal Society of Arts will be delivered by Sir William Bragg at the Society's house, Adelphi, at 8 o'clock on Wednesday, January 24. The subject will be "The New Methods of Crystal Analysis, and their Bearing on Pure and Applied Science."

A NEW section of the Royal Microscopical Society has been formed for the purpose of dealing with the practical use of the microscope in connexion with industrial research. The inaugural meeting of the section will be held at 20 Hanover Square, W.1, on Wednesday, January 24, at 7 o'clock.

THE following free public Gresham lectures will be delivered at Gresham College, Basinghall Street, at 6 o'clock, on the dates named :—Physic, by Sir Robert Armstrong-Jones (January 23, 24, 25, and 26); Astronomy, by Mr. A. R. Hinks (January 30, 31, and February 1 and 2); Geometry, by Mr. W. H. Wagstaff (February 6, 7, 8, and 9).

THE Silvanus Thompson Memorial Lecture will be delivered at the Technical College, Leonard Street, E.C.2, on Thursday, February 1, at 7.30 P.M., by Sir Oliver Lodge, who will take as his subject "The Basis of Wireless Communication." The chair will be taken by Sir Charles Parsons. After the lecture a conversazione and re-union of old students will be held. A collection of Prof. Thompson's paintings and apparatus will be shown and a number of demonstrations will be given in the laboratories.

A COMMITTEE, consisting of representatives of the Institutions of Mechanical Engineers and Naval Architects, has been appointed with the object of carrying out tests on oil engines and of reporting on the performance of motor-driven vessels. The Engineer-in-Chief of the Fleet has, with the approval of the Admiralty, joined this committee. In scope, the proposed trials will include economy and thermodynamic tests ashore and manœuvring tests at sea. Wherever possible the behaviour of the propellers and the hull will be examined. It is intended to test engines of as many representative types as possible. The first actual testing work will probably be carried out about April next.

THE National Institute of Agricultural Botany is now accepting entries for its second series of yield and quality trials of new varieties of potatoes from breeders who are willing to entrust the Institute with the marketing of their productions on a profit-sharing basis. The trials are planned to last for five years, at first in Scotland only, but in the later years also in the English potato districts. Only those varieties which do sufficiently well in the trials will be placed on the market. Full particulars of the conditions of the trials can be obtained from the Secretary, N.I.A.B. Huntingdon Road, Cambridge, to whom those intending to enter new varieties for these trials should apply not later than February 28.

WE have received a copy of the programme, rules, and regulations of the International Exhibition for Photography, Optics, and Cinematography, which is to be held at Turin during next May and June in the Newspaper Palace at the Valentino Park, under the initiative of the Board of Trade and Industry at Turin, and under the high patronage of H.M. the King of Italy. The photography section is divided into seven classes, and each class into several sub-classes. Photography in general, optical projection, photomechanical methods, photography in its application to science, photographic materials and literature, are all included. The optical section includes optical glass, machinery for making lenses, prisms, etc., spectacles of all sorts and oculists' apparatus, microscopes, telescopes, opera glasses, optical instruments in general, bibliography, and schools. The cinematography section is similarly classified. Applications to exhibit must be made on forms that will be supplied and which must arrive, duly filled in, not later than March 1 at the General Commissary, Via Ospedale, 26, Turin (the head office of the executive committee.)

THE character of the primitive Crustacean limb was disputed between Mr. E. W. Shann and our reviewer in our issue of December 2 (p. 736). In fairness to the former, a statement of the present state of knowledge seems called for. It is now generally held by the leading authorities that Trilobites represent the ancestral group from which Crustacea were derived. All investigated species of these appear to have had biramous limbs, while some of the most primitive had the posterior region of the body relatively soft and uncalcified, and were in process of evolution from Annelids. Hence if the Apodidæ (and all other Crustacea) arose from Trilobites possessing biramous limbs, their own foliaceous appendages must be presumed to be derived from the biramous type, notwithstanding the similarity of their structure to the foliaceous uniramous parapodia of some Annelids. It is possible that the bilobed type of parapodium possessed by many Annelids may have given rise to the biramous Crustacean limb. On the other hand there is the objection felt by a few that the descent of the Apodidæ and other Crustacea from an ancestral group of Trilobites does not necessarily follow from the fact that Trilobites are the earliest known Crustacea. The Apodidæ themselves have many structural affinities with Annelids. Thus it is conceivable that the Crustacean-Annelid may have produced divergent branches of which the Trilobites (biramous-limbed) represent one, and the Apodidæ (foliaceous-limbed) the other. This view, however, is not regarded with favour by the chief authorities.

At the sitting of the French Academy of Sciences held on October 23, 1922, a note was presented by MM. Constantin, Joessel, and Daloz "concerning a boat which travels against the wind while using the wind itself for motive power." An article on the same topic, entitled "Un bateau paradoxal," appears in *La Nature* of November 11. An ordinary sailing-boat cannot use the wind for directions which are too near that directly opposite to the wind, and it was long ago suggested that if an arrangement like the sails of a windmill were substituted for ordinary sails, the boat could travel even against the wind. Napoleon was urged to use this as a means of surprising the British fleet. Scientific work on the idea was initiated in 1901 by Constantin, who constructed a model car on wheels which advanced against a current of air blown on it. The publication of Drzwiecki's theory of propellers in 1909 encouraged Constantin to proceed further. He attracted the attention and approval of many French men of science, and a syndicate was formed for the development of the method, but the war interrupted the work. In 1917 work was resumed, and since then the idea has been applied successfully. Joessel (son of the well-known investigator in aerodynamics) put an air-screw—like the sails of a windmill—of 5 metres diameter into a 2-ton sloop, *La Drésinette,* connected with a marine propeller of 60 cm. diameter, and successful journeys were made on the Erdre, near Nantes, and on the Loire. This was in 1918. Later on a 9-metre air-screw was installed in the 5-ton boat *Bois Rosé*, connected with a marine propeller of 105 cm. diameter, and on September 15, 1922, this boat sailed successfully on the Seine, between Saint Cloud and Sèvres, in all winds and against the wind, without causing any derangement in the ordinary traffic. It was estimated that the speed was 2 metres per second against a wind of 7 metres per second. The investigations were conducted with the help of the French *Direction des recherches scientifiques et industrielles et des inventions.*

Our Astronomical Column.

The Planet Mercury.—This planet reaches its easterly elongation on January 13 and will be favourably placed for naked-eye observation at about that date.

The best time to obtain a glimpse of the planet will be at about an hour after sunset, when it may be seen at a low altitude over the west-south-west horizon. The planet may be expected to be about as bright as a first magnitude star would appear in a similar position and involved in twilight. Mercury does not shine with the same steady light as some of the larger planets, but often exhibits a sparkling fitful lustre.

Being rarely visible owing to its proximity to the sun, it is necessary for intending observers to look for the planet at special periods like the present, when its apparent elongations from the sun enable it to be perceived with the unaided eye.

The January Meteors.—A brilliant full moon and passing clouds somewhat interfered with observation of this event. The maximum display was expected on January 3, and Mr. W. F. Denning writes that at Bristol fine meteors were visible occasionally, and indications were that had the conditions been favourable, the shower would have been fairly conspicuous and plentiful.

At Stowmarket, Miss A. Grace Cook and Mr. J. P. M. Prentice obtained independent observations on the night mentioned, and remarked some fine meteors from the usual point of radiation at $232° + 52°$.

The sky was not watched after midnight and the maximum seemed to have been attained in the earlier part of the evening. Miss Cook recorded bright meteors from the special shower of Quadrantids at $6^h 58^m$, $8^h 10^m$, $8^h 43^m$ and $10^h 18^m$, and there were others of about mag. 1. At $9^h 36^m$ there was a fireball from the direction of Aquarius.

On the night of January 4, the shower of Quadrantids seemed to have become nearly extinct. At $8^h 48^m$, however, Miss Cook witnessed the appearance of a remarkable stationary meteor. It was as bright as Venus, and shone for about $1\frac{1}{2}$ seconds with a motionless aspect at the position $222° + 77°$. There is a known shower at this point in Ursa Minor and it corresponds with the point of radiation of Mechain-Tuttle's Comet on December 20.

Coming Solar Eclipses.—The eclipse of September 10, 1923, will be total in California and Mexico. The sun's altitude will be more than 60°, and the duration of totality $3\frac{1}{2}$ minutes. The weather prospects are very hopeful. There is little doubt that the Einstein problem will again be studied. Mr. F. Slocum (*Astr. Journ.* No. 809) gives a list of the stars within $2\frac{1}{2}°$ of the sun's centre down to mag. 9·0. They are mostly faint, especially those nearer the sun, and it will need skilled photography to record them. It is proposed to photograph a check field, some 5° distant, on the same plates during totality, thus giving an independent determination of scale value, and enabling the whole Einstein displacement to be utilised. Otherwise much of it is lost, only the differential shift being available.

The succeeding totality, on January 24, 1925, crosses the north-eastern states. Four observatories —Vassar, Yale, Van Vlack, and Nantucket—enjoy total eclipse; its duration is $1\frac{1}{2}$ minutes, but the sun's altitude is less than 20°. The star field is better than that of 1923 but not so good as 1919.

Research Items.

The Pilou Feast in New Caledonia.—A valuable account of the festival known in New Caledonia as *Pilou*, a word which seems to mean "repetition, rhythm," in connexion with the ritual dances forming a leading part of the ceremonial, is given in *L'Anthropologie* (vol. xxxii. Nos. 3-4) by M. Maurice Leenhardt. The object of this elaborate series of dances and ritual seems to be the periodical expulsion of evil spirits and other dangers, which has been fully discussed by Sir James Frazer in "The Golden Bough," 3rd ed., The Scapegoat, chaps. iii. iv. This article, fully illustrated by drawings and photographs, deserves the attention of anthropologists.

Pencil Pigments in Writing.—In the issue of *Discovery* for January, Mr. C. Ainsworth Mitchell discusses the question of the identification of pencil pigments in writing. He shows that the microscopical appearance of lead and its alloys is quite distinct from that of graphite, the lines showing a disconnected series of patches irregularly distributed, uniformly and brilliantly lit up, and each patch is marked with regular vertical striations. Writing in different pencil pigments may sometimes be differentiated by chemical tests. For example, the graphite and clay used for the pigment frequently contain very varying amounts of iron or of chlorides, and the markings with them show reactions of different intensities when tested with the respective reagents. Titanium is also a common constituent of natural graphites, but seldom sufficient to give a distinct reaction in the markings on paper. In that case, however, a colour test alone was sufficient to distinguish the marks made with that pencil as compared with others examined.

Glands of the Microdrili.—Dr. J. Stephenson (Trans. R. Soc. Edin., liii. pp. 241-265, 1 plate, 1922) has investigated the septal and pharyngeal glands of the four families of Microdrili (Oligochæta)—Tubificidæ, Enchytraeidæ, Naididæ, and Lumbriculidæ. In the anterior segments are numerous deeply staining cells associated with the blood vessels, muscular strands, septa (forming the "septal glands"), body-wall, and pharynx and œsophagus (forming the "pharyngeal glands"). Only in the Enchytraeidæ do the cells discharge into the lumen of the pharynx; their products—largely disintegration products—penetrate between the cells of the dorsal wall of the pharynx. In none of the species examined do cell processes of the "glands" penetrate the alimentary wall. The cells (except in the case of the Enchytraeidæ) appear to constitute ductless glands and their secretion mixes with the coelomic fluid. The cells arise from the peritoneal lining of the coelom and not from the alimentary epithelium.

Oospore Formation in Phytophthora.—A note of considerable interest to mycologists is contributed by S. F. Ashby to the *Kew Bulletin* (No. 9, 1922, pp. 257-261) upon the formation of oospores in a species of Phytophthora, *P. Faberi* Maubl. The author has isolated from the cacao plant in Jamaica and Grenada, from rotting cotton bolls in St. Vincent, and from the coconut palm in Jamaica, strains of Phytophthora, apparently this species, which appear identical in growth in pure culture save that the strain from cacao seems less vigorous. In pure cultures oospores are not formed upon any of these strains, but if the strain from cacao is grown in mixed culture with either of the other two strains, oospores appear regularly in the culture as the mycelia interpenetrate and persistent antheridia are present. So far these interesting observations would admit of interpretation upon the assumption of heterothallism so thoroughly worked out by Blakeslee for the Mucoraceæ, but Ashby's observations upon the result of mixing strains of this species with a strain of the distinct species *P. parasitica* Dast. isolated from Ricinus in India are totally unexpected. Oospores are developed in such mixed cultures but are throughout of the diameter characteristic of *P. Faberi*, the smaller oospores of *P. parasitica* not being detected. The further development of this interesting work will be followed with great interest.

Philippine Earthquakes.—We have received a reprint of the *Weather Bulletin* (for December 1920) of the U.S. Weather Bureau containing the catalogue of Philippine earthquakes for the year 1920. The number of shocks recorded (147) is close to the average (150) for the last eighteen years, though only one (the Benguet earthquake of October 8) was strong enough to cause slight damage to buildings. In two useful tables are given the monthly numbers of earthquakes felt in the Philippines for every year from 1903 to 1920, and also similar numbers of earthquakes recorded at Manila, the total numbers being respectively 2609 and 5781. An interesting result obtained from these tables is that, as in other insular seismic districts, the earthquakes of the Philippines are subject to a very slightly marked annual period.

Oil in Russia.—Some aspects of the occurrence of oil in Russia formed the subject of a paper read by Mr. T. G. Madgwick before the Institute of Petroleum Technologists on December 12. The author considered briefly the geology and structures of the principal fields, and by a generalised correlation of these widely distributed occurrences, attempted to forecast the future possibilities of the country as an oil producer, both as regards existent and potential resources. While it may be doubted whether such prolific pools as those of Baku will ever be struck again (the conditions here being peculiarly favourable to oil accumulation), so much unprospected territory, at least technically favourable, remains to be examined, that he would be a bold man who prophesied a non-recurrence of industrial achievements which at one time rivalled even those of the United States. The cure for the present ills of the Russian petroleum industry lies in the establishment of political and economic stability, in reorganisation of existing fields, and in a business-like system of production. The author also stressed the necessity for giving serious attention to certain technical problems, in particular water troubles, which even before the Revolution were causing anxiety to many producers. Developments of existing fields may be expected in the Caucasus (Terek region), in the eastern end of the Apsheron peninsula, and in the lower part of the Kura river. The unknown factor, however, is unquestionablyTranscaspia; the Emba district, N.E. of the Caspian Sea, is already a producing field, but vast areas, at present almost inaccessible, await exploration, both to the east and north-east; these prospects have the added merit of being scientifically favourable, at all events in so far as our present geological knowledge of Asiatic Russia is concerned. The author left out of consideration the Sakhalin and Eastern Siberian prospects; these isolated occurrences are only imperfectly known and in any case they can have no relationship with the main resource-area under review; from the geological point of view, they are more closely allied to the occurrences in Japan, and may ultimately be expected to reveal similarities both in development and economic magnitude to that country.

ELECTRICAL DISTRIBUTION ON TWO SPHERICAL CONDUCTORS.—In a recent paper to the Physical Society Dr. Alexander Russell returns to the electrostatic problem of two spherical conductors. The most interesting feature of the investigation is the fact that Kelvin's method of images is not the best way to attack the problem. The author shows how Poisson's method can be made to yield useful results, amenable to easy and accurate numerical computation. The principle of the method is as follows. A functional form is postulated for the potential at any point of the actual but unknown electrical distribution on each sphere, and the constancy of the potential on each sphere is used, coupled with the theory of inverse points. The two cases, (1) one sphere inside the other and (2) the spheres outside one another, are discussed in detail, and applications are made to find the force between the spheres, the energy, and the stress in the medium.

AN AUTOMATIC VOLTAGE REGULATOR.—For electric lighting it is essential that the voltage of the dynamo should vary only between very narrow limits. In country house lighting where the direct current dynamo is driven by a petrol motor the voltage variations sometimes cause serious and very objectionable fluctuations of the light. Messrs. Isenthal and Co., Ltd., now manufacture an automatic rapid action voltage regulator suitable for use with dynamos up to 50 kilowatt capacity. The device is extremely simple, and by its use the voltage can be maintained practically constant even when the driving speed and the load vary very suddenly. The principle employed is practically the same as that used in other vibratory regulators some of which, the Tirrill regulator, for example, are extensively used in electric lighting stations. Messrs. Isenthal's regulator is, however, applicable to quite small machines, and should prove very useful.

GLIDING FLIGHT.—*Die Naturwissenschaften* of October 6, 1922, contains an article by Prof. C. Runge, of Göttingen, entitled "Uber den Segelflug," reproducing a lecture delivered at Wasserkuppe during the German gliding contests last August. Prof. Runge gives a clear account of the main principles underlying gliding or sailing flight. After emphasising the point that a steady horizontal wind is useless for the purpose, the author divides useful winds into two categories, (1) steady winds in upward directions, and (2) variable winds. The former can be used in gliding flight if the vertical component is at least equal to the rate of vertical fall of the glider, and Prof. Runge points out that upward winds are of frequent occurrence; that, in fact, ordinary air movements in the form of wind are primarily vertical, but are horizontal more or less to us because we live at that stratum of the atmosphere affected by the earth's solid crust. In the case of variable winds, several kinds of variations are possible: thus different air layers may have different speeds, or the air in any one layer may have different speeds at different times. An attempt is made to explain non-mathematically how such variation can be used for flight. The effect of dimensions is also considered briefly.

LOSS OF HEAT FROM SURFACES.—At the request of the Engineering Committee of the Food Investigation Board, Dr. E. Griffiths and Mr. A. H. Davis of the National Physical Laboratory have carried out a series of measurements to determine the laws of gain or loss of heat by solid surfaces in contact with air at temperatures which differed from their own, and the results are embodied in the recently issued Report No. 9 of the Board (H.M.S.O., price 1s. 6*d*.). It is shown that the loss or gain is mainly due to the convection currents set up in the air close to the surface, and that the amount of heat transmitted per unit time and area is proportional to the 5/4ths power of the difference of temperature of surface and air, a law first stated by Prof. L. Lorenz in 1881. Unfortunately the factor of proportionality is not independent of the shape, size, and orientation of the surface, the loss for the same difference of temperature being greater per unit area and time for a small surface than for a large, and for a horizontal surface facing upwards than for one facing downwards. The authors give curves from which the proper value of the factor can be obtained in any practical case, so that the Lorenz law may be readily used by heating, ventilating, and refrigerating engineers.

UPPER-AIR WINDS IN INDIA.—Memoirs of the Indian Meteorological Department, vol. xxiii. Pt. III., which has just reached us, contains mean monthly characters of upper-air winds deduced from the flights of pilot balloons at thirteen stations in India during the period 1910 to 1919. The discussion has been carried out by Mr. J. H. Field, director of the Agra Observatory, and is published under the direction of the Director-General of Observatories. It contains nearly 100 foolscap pages of figures, with two pages of explanation. At many of the stations the observations are for a few months only and it is not easy to select a period with consecutive observations at several stations. The stations are distributed fairly well over India. Good comparisons can be obtained for the greater part of 1919, and these observations show a general increase in the speed of the wind with height, which is greater in winter than in summer, although this varies with the latitude, being more marked in northern India, according to the observations in February and August at Lahore, Agra, and Akyáb, than in the south as shown by Bangalore. Naturally there is also much variation in the direction of the wind of the upper air at different seasons. To plot graphically the observations for the several stations for the several months and for varying heights would involve considerable labour, but where air-ways are to be used such plotting seems essential. The data will supply much which is of interest relative to the movement of the upper-air over India, and associated with what is known at the earth's surface, it will afford most useful and instructive information.

A NEW BECK MICROSCOPE.—Messrs. R. and J. Beck, Ltd., 68 Cornhill, E.C., have submitted to us an example of their Model 22 "London Microscope." The instrument is simple in design and is supported on a modified horse-shoe base with widespread limbs, which gives complete stability even in the horizontal position The coarse adjustment is of the spiral rack and pinion pattern, the fine adjustment is of the vertical type with milled head. The stage is a large one measuring 4 in. × 3½ in. With one eye-piece, and a low-angled ⅔ in. and a ⅙ in. objectives in canvas-covered case, the price is the moderate one of 8*l*. 17*s*. 6*d*. Double or triple nose-pieces are supplied at an additional cost of 1*l*. 1*s*. and 1*l*. 10*s*. respectively. A spiral, screw focussing, swing-out condenser of the Abbe type with centring screws, cell, and iris diaphragm costs an additional 2*l*. 7*s*. 6*d*. The instrument is well made and thoroughly efficient and is suitable for all ordinary microscopical work. Additional objectives and other fittings can be supplied if desired.

Exhibition of Physical Apparatus.

TIMES have changed since Lord Bacon had to complain that "the mechanic, little solicitous about the investigation of truth, neither directs his attention nor applies his hand to anything that is not of service to his business." The modern "interpreter of Nature" would contribute scantily to the advancement of learning were he bereft of the mechanic's services, and it is by a happy thought, therefore, that the Physical and Optical Societies bring together every year the manufacturers and users of scientific instruments. At their thirteenth annual exhibition, held at the Imperial College of Science on January 3 and 4, such a wealth of beautiful, and in many cases novel, apparatus was to be seen that we can only refer to a few of the particularly interesting exhibits, selected somewhat arbitrarily.

Of special interest to engineers was a micro-indicator (Cambridge and Paul, Ltd.) for high-speed engines, in which the dimensions of the parts eliminate inertia-errors. A specially designed stylus cuts on celluloid a minute indicator-diagram which can be enlarged photographically or examined at once with a microscope. The Elverson oscilloscope (Herbert Kennedy and Co.) by intermittent illumination made a machine at 1500 revolutions appear to be either stationary or working at 150 revolutions, enabling faulty action to be detected and located. A fine adjustment for speeds derived from a phonic motor was shown in a strobometer (Tinsley and Co.), and comprises a friction gear providing an infinitely variable speed. A tapered drum driven from the phonic motor engages an axially movable friction wheel which carries contacts controlling the intermittent illumination of a stroboscopic disc or the like, the position of the wheel indicating the frequency of the illumination as a percentage of that of the tuning fork which governs the phonic motor.

Much interest was expressed in the new celluloid mirrors (Adam Hilger, Ltd.), the thickness of which is equal to a few wave-lengths of light. These were applied to vertical illumination in a microscope (an arc lamp failing to heat the celluloid on account of its thinness), to acoustic purposes in an optical sonometer, and to the transposition of colour combinations in patterns in the chromoscope (The Chromoscope Co.). In the latter apparatus each element of the design is prepared as a stencil for use in conjunction with a Wratten colour screen which can be changed at will, and by means of an optical device the various elements are viewed in superposition by transmitted light. Other novelties by Hilger were an interferometer attachment for calibrating microscope racks, indicating backlash, and checking the fit of the slide; and some ultra-violet spectrograms on the new Schumann plates which, with a minimum of gelatine and a fluorescent component in their emulsion, require a remarkably short exposure. The latest "Demonstrator's Lantern" (Newton and Co.) could be arranged at will for projecting ordinary slides, for opaque objects, for vertical projection, or for microscopic, polariscopic, or spectroscopic projection. Among microscope improvements might be noted a stand and sub-stage (R. and J. Beck, Ltd.) designed to prevent mechanical disturbances from causing the disappearance of objects from the field of view under high power. The enhanced resolving power obtained by the use of crossed Nicols was demonstrated with this instrument. A new saccharimeter (Bellingham and Stanley) exhibited several novel features. The polarising prism is constructed without the use of cement, the visible edge of the half-prism is a natural edge of the crystal, and the quartz plate, compounded of right- and left-handed quartz wedges, is within the size limit for which flawless crystals are obtainable.

An annual feature of the exhibition is the display of radium apparatus for medical and demonstration purposes by Mr. Harrison Glew. Every year it is a pleasure to see this pioneer, to whom suffering humanity owes no small debt. A radiological ionometer (Watson and Sons) comprised an ionisation chamber connected to an electroscope and arranged for measuring the precise X-ray dosage administered to a patient. Another medical instrument was that for estimating the carbon dioxide content of alveolar air (Cambridge and Paul). It employs a Shakespear katharometer, the thermal conductivity of a breath sample being compared electrically with that of pure moist air. The smoke nuisance received attention in Dr. E. A. Owen's automatic air filter and his jet apparatus (Casella and Co.). In the former, samples of air are strained through white filter paper at regular intervals, the dust content being estimated from the colour of the resulting deposit. In the jet apparatus, a jet of moist air impinging normally on a glass slip is found to deposit its dust, which can then be examined microscopically.

Of electrical testing apparatus there was an immense variety, from the high-frequency low-voltage Moullin voltmeter (Cambridge and Paul), which employs a triode valve so arranged as to preclude disturbance of the circuits to be measured, to the "Meg" insulation tester (Evershed and Vignoles, Ltd.), a remarkably light and cheap megger running to 10,000 mgo. which should prove a boon to linemen. A multiversal test set by Elliott Brothers claimed to measure milliamperes, kilovolts, capacities and much else, besides functioning in Varley and Murray loop tests. A novel relay for radio signals was that designed by Mr. Anson (Tinsley and Co.), in which a neon lamp in the anode circuit of a triode valve intensifies current variations on account of its negative characteristic.

Demonstrations of actual manufacturing processes were given by the Igranic Electric Co. (automatic winding of transformers) and Dallmeyer, Ltd. (lens-making shown by kinematograph); and examples of the daily work of the National Physical Laboratory aroused much interest. Each day Mr. W. Gamble lectured on the "Reproduction of Colour by Photographic Processes," an outstanding feature of his lecture being the projection of slides made by the new Eurochrome process, recently acquired from Germany by the Austrian State Printing Office. The results of this process, the nature of which is somewhat obscure, mark a substantial advance in the art. Prof. E. G. Coker lectured on "Recent Photo-Elastic Researches on Engineering Problems," giving a beautiful demonstration of his method, in which the distribution of stress in transparent models is traced by means of polarised light. In this way he showed the effect of shape on stress-distribution in chain links, tensile and compressional test specimens, and gear and worm wheels in action. He also demonstrated the stresses set up during turning, planing, and milling, showing that the cutting edge is preceded by a region of compression and followed by one of tension, the shaving itself being free from stress in the neighbourhood of its point of attachment. With a burred edge the stresses were seen to oscillate.

Mr. F. E. Smith, who made the necessary arrangements, is much to be congratulated on the success of the exhibition which failed to furnish any experimental evidence for the unluckiness of its number. Some fifty-six exhibitors participated. C. W. H.

Scientific Expeditionary Research.

A SMALL meeting, which was attended by representatives of several of the sciences more immediately concerned, was held in the rooms of the Linnean Society, on January 3, under the presidency of Sir Kenneth MacKenzie, Bart., to discuss the formation of a "Scientific Expeditionary Research Association"; and it was agreed that this action should be taken. The general objects of the scheme, as stated in a draft which had been prepared before the meeting, are to facilitate and promote scientific research by means of expeditions to all parts of the world. The association, which is to be precluded from making any distribution of dividends or bonus in money, is to consist of a body of fellows and members, and any profits which may accrue from its operations are to be devoted to the objects stated.

It is proposed to commence with an expedition to the Pacific, visiting islands which lie off the beaten track, and the journey is to be undertaken in a sailing ship. The necessary funds are to be provided by the contributions, at a fixed rate, of about fifty persons of either sex who may be expected to take a general interest in the work of a scientific expedition. A more definitely scientific nucleus is to be provided by the nomination, by scientific societies or in other ways, of from six to ten suitably qualified persons who would not be expected to make any contribution in money.

It is believed that the scientific members of the party would be able to carry out investigations during the cruise or at islands at which a halt was to be made, and that they would be able to interest and obtain assistance from the others. The itinerary, which would be decided beforehand, would be arranged so as to facilitate work of a serious nature, and the plan of the tour would be devised with special reference to the investigations it was proposed to carry out. This matter would be in the hands of an advisory council, in which it is hoped that it will be possible to include representatives of various sciences who could assist in drawing up a practicable scheme. It is believed that there would be a profit on the first cruise, and that this would be available for partly financing the next expedition, supplemented by receipts from other sources, such as the subscriptions of fellows and members, the profits of lectures and the sale of specimens and publications. The existence of an organisation which would be able to send out scientific expeditions as required, from time to time, would be likely to prove extremely useful in advancing natural knowledge.

The promoters of the scheme believe that they will have no difficulty in obtaining the support necessary to enable them to carry out their first expedition. If this can be done, it seems obvious that there should be many opportunities of obtaining valuable collections of animals, plants, and rock-specimens; and that the investigation of these collections is likely to yield results which will give the association the right to claim that a part of its objects has been accomplished. It was pointed out at the meeting that success in carrying out research-work during the cruise was likely to depend mainly on the possibility of finding qualified investigators who would be able to accompany the expedition, and of planning a tour which would give scope for the execution of the work on which they were severally engaged. The meeting can scarcely be said to have been in a position to decide how this could be done, and no definite scheme has at present been thought out. The difficulties were admitted, but the opinion was expressed by certain speakers that they could be surmounted, by the restriction of the efforts of each cruise to a series of investigations which would not be incompatible with one another.

The officers of the association are Sir J. Kenneth D. MacKenzie, Bart. (president), Commander D. Blair, R.N.R. (marine superintendent), and Mr. Frederick W. Kealey (organising secretary); and the offices are at 68 Pall Mall, S.W.1, from which further information can be obtained. Suggestions as to lines of work which could profitably be undertaken during the first cruise would be gladly received by the officers, and it is particularly desirable to receive the names of well-qualified scientific investigators who would be prepared, if appointed, to accompany the expedition and to carry out specified researches.

Geography in Education.

THREE matters of scientific interest were discussed at the annual meetings of the Geographical Association. Sir John Russell, of Rothamsted Experimental Station, gave the presidential address on "The Influence of Geographical Factors on the Agricultural Activities of a Population." Confining his illustrations to Britain, he pointed out that in earlier times each village community had to be self-supporting, and that agricultural systems were uniform all over the country. This implied that certain areas, mainly heavy clays and light sands, were perforce left vacant, and that the drier south and east were the most attractive for agriculture and settlement. With later improvements of transport and increased knowledge of how to combine animal production with the growing of grain and other vegetable foods, the action of the geographical factors was modified, and the modification seems now to be in process of being carried a step further, as different parts of the country are specialising in productions, mainly luxuries, for which they are specially suited.

Dr. Olive Wheeler, of the University of Manchester, spoke of "The Place of Geography in the Education of the Adolescent." She approached the matter from the point of view, not of subjects, but of the pupils. She considered specially the physical and mental development of young people between the ages of 12 and 16. She pointed to the quick growth in bulk and the rapidity of bodily changes, and emphasised also the extreme importance of the new emotional experiences, social, æsthetic, and religious, as well as sexual. Any education worth the name must take account of the fact that boys and girls of the ages considered are, consciously or unconsciously, attempting to find a philosophy of life. It is the business of teachers to arrange that the process is carried on with tolerance and broadmindedness. To do this it is necessary that education should deal with the study of matter on one hand and with the development of personality by means of the humane subjects on the other. Dr. Wheeler then emphasised again the position of geography as a correlating subject in which is considered not only how matter affected man but how man affected matter. Geography, probably, better than any other subject helped boys and girls to obtain a true philosophy of life.

Prof. Tower, American commercial attaché, American Embassy, lectured on "Geography in Business

Life." If Dr. Wheeler stressed the value of geography in living, Prof. Tower emphasised the value of geography in earning one's living, and gave examples. He referred to an institution in the United States, at which the finger of scorn was pointed because it took as its motto "Anything to catch the nimble nickel." It was significant that geography had been taught there for many years, is still being taught, and there is no suggestion that it should go out. Even more striking was the case of one of the great trade houses of New York—of international reputation—which looked for a trade adviser, not to get business himself but to help other heads of departments. They were advised by their chartered accountants to appoint a geographer as the most suitable man, and did so. Prof. Tower told also of a convention of eighty administrative heads of great business houses in the United States. In each of the last three years there have been discussions of the relations of geography teaching to trade and business, and most of the important geographers have contributed to the discussion. It is significant that this course was adopted by men who never were taught geography themselves as it is taught now, and knew only what modern teaching has done.

Mr. E. J. Bradford, of the University of Sheffield, read a paper at the annual meeting of the Geography Section of the Training College Association. The paper dealt with the results of a geography test given to various classes in secondary schools, and was noteworthy in that it was set neither by an external authority to pass or fail candidates nor by a teacher to find out what his pupils knew. The test was set for purely scientific objects. The methods bear some resemblance to those of intelligence tests, but were constructed with the view of finding, not the intelligence of the pupils but the effectiveness of the geography teaching from year to year. The results were extremely interesting, but admittedly the experiment is only in its initial stages, and it would not be fair to state the conclusions tentatively drawn, as they may be modified.

Paris Academy of Sciences.

Prize Awards for 1922.

AT the meeting of the Paris Academy of Sciences, held on December 18, the following prizes and grants for 1922 were awarded:

Mathematics.—The Grand prize of the Mathematical Sciences to Jean Le Roux for the whole of his work; the Poncelet prize to Jules Drach for the whole of his work in mathematics; the Francœur prize to Louis Antoine for his works on geometry.

Mechanics.—The Montyon prize to Farid Boulad; the Fourneyron prize to J. A. Farcot d'Albaret for his work on the gas engine; the Henri de Parville prize to Henri Béghin for his memoir on the theoretical study of gyrostatic compasses.

Astronomy.—The Lalande prize to Henry Norris Russell for his work in physical astronomy; the Valz prize to Jean Chazy for studies in celestial mechanics, and particularly for his memoir on the course of the movement in the problem of three bodies when the time increases indefinitely; the Janssen medal to Carl Störmer for his theoretical and experimental researches on the aurora borealis.

Geography.—The Delalande-Guérineau prize between Achille Lamotte and Charles Mailles (in equal parts); the Gay prize to Ludovic Gaurier for his explorations in the Pyrenees; the Binoux prize to Paul Le Cointe for his study of the river Amazon; no award was made of the Tchihatchef prize.

Navigation.—The prize of six thousand francs between Maurice Garnier (3000 francs) for his work on the calculation of trajectories by successive arcs, André Vinsot (1500 francs) for a contribution to the study of the tactics of loosing torpedoes, and Henri Roussilhe (1500 francs) for his hydrographical researches; the Plumey prize to Edouard Sauvage for his work on steam engines.

Physics.—The L. La Caze prize to Anatole Leduc for the whole of his scientific work; the Kastner-Boursault prize to Camille Gutton for his work in electricity, and more particularly on Hertzian waves; the Hébert prize to Charles Chéveneau for his work in electricity and magnetism; the Hughes prize to Camille Raveau for his work in various branches of theoretical physics; the Clément Felix foundation to Alexandre Dufour for the continuation of his researches on the registration of Hertzian waves.

Chemistry.—A Montyon prize (Unhealthy Trades) (2500 francs) to (the late) Charles Boulin for his researches on mustard gas; an honourable mention (1500 francs) to Louis Tampier for his work on the manufacture of poison gas; the Jecker prize between Marcel Godchot (5000 francs), Marc Bridel (2500 francs), and Georges Tanret (2500 francs) for the whole of their chemical work; the La Caze prize to Paul Thiébaud Muller for his physico-chemical researches; the Cahours foundation to Andrée Chaudun for her physico-chemical study on sugar inversion; the Houzeau prize to René Dubrisay for his work on solutions.

Mineralogy and Geology.—The Victor Raulin prize to Louis Longchambon for his researches on the relation between rotatory power and crystalline symmetry.

Botany.—The Desmazières prize to Edouard Chatton for his work on the Protozoa, Louis Emberger and Ethel Mellor receiving honourable mentions; the Montagne prize to Etienne Foëx for the whole of his work in mycology; the La Fons Mélicocq prize to Pierre Allorge for his memoir on the botanical geography of the French Vexim; the de Coincy prize to Marcel Denis for his work on the Euphorbiaceæ.

Anatomy and Zoology.—The Cuvier prize to René Koehler for his researches on the echinoderms; the Savigny foundation to Jacques Pellegrin for his memoir on the fresh-water fishes of Northern Africa; the Thore prize to Lucien Chopard for his work on the Orthoptera.

Medicine and Surgery.—Montyon prizes to Charles Dopter (2500 francs) for his book on meningococcic infection, Eugène Wollman (2500 francs) for his studies on life in the absence of micro-organisms, Edmond Lesné and Léon Binet (2500 francs) for their book on the normal and pathological physiology of the infant; honourable mentions (1500 francs) to Emile Weil and Jean Loiseleur for their works on pneumo-serous diagnoses and therapeutics, J. B. Piot-Bey for his work on the organisation and working of the veterinary service of the state domains of Egypt, and Philippe Lasseur and Louis Spillman for their book on antibody reactions, a quantitative study of the fixation of alexine; citations to André Feil for his memoir on the absence and diminution of the cervical vertebræ, to Serge Tchahotine for his researches on experimental cytology made with the microscopic radio-puncture method, to Maurice Fontoynont and Humbert Boucher for their contribution to the study of the mycoses of Madagascar; the Barbier prize to Edmond Delorme for his work on pulmonary decortication; the Bréant prize between

Marie Phisalix, for her book on poisonous animals and their venoms, and Edmond and Étienne Sergent, for their work on the etiology and prophylaxy of Debab, a trypanosomiasis of the dromedary of Northern Africa; the Godard prize to Jean Turchini for his studies on the cytological processes of elimination of colouring matters by the kidney; the Mège prize to Pierre Mathieu for his researches in experimental physiology; the Bellion prize between Giuseppe Favaro (700 francs), for his book "Lo spatium supragenuale e le formazioni in esso contenute," and Arthur Vernes (700 francs), for his researches on the measurement of flocculation by photometry; the Baron Larrey prize to Pierre Perrin de Brinchambaut for his book on the criteria of aptitude for flight in aeroplanes.

Physiology.—The Montyon prize to Gaston Giraud for his memoir on medio-cubital association in wounds of the upper member; the La Caze prize to Léon Fredericq for the whole of his work in physiology; the Pourat prize to René Wurmser for his memoir on researches on chlorophyll assimilation; the Martin-Damourette prize to Pierre Abrami for his researches on the pathogeny and treatment of marsh fevers; the Philipeaux prize to Costantino Gorini for his studies on the lactic fermentation.

Statistics.—The Montyon prize to Pierre Richard for his work on the mathematical theory of assurance.

History and Philosophy of Science.—The Binoux prize to Gino Loria for his historical works.

Medals.—The Berthelot medal to Charles Boulin, Marcel Godchot, Marc Bridel, Paul Thiébaud Muller, René Dubrisay.

General Prizes.—The Alhumbert prize to Charles Mauguin for his work on liquid crystals; the Bordin prize to Joseph Magrou for his memoir on symbiosis and tuber formation; the Lallemand prize to Paul Wintrebert for his work on the nervous systems of embryonic vertebrates; the Vaillant prize to Wladimir Vernadsky for the whole of his work in mineralogical chemistry; the Houllevigue prize to Rodolphe Soreau for his work on aviation and book on nomography; the Saintour prize to Serge Metalnikoff for his work in immunology; the Henri de Parville prize between Robert Lespieau (2000 francs), for his book on the chemical molecule, and Léon Toraude (500 francs), for his historical publications; the Lonchampt prize to Henri Colin for his work in plant physiology; the Henry Wilde prize to Carl Benedicks for his memoir on the homogeneous electro-thermic effect; the Caméré prize to Jules Bied for his researches on cement; the Victor Raulin prize between Philippe Schereschewsky and Philippe Wehrlé (1000 francs) for their memoir on cloud systems, and Augustin Boutaric (500 francs) for his work on the intensity of solar radiation; the Gustave Roux prize to Pierre Teilhard de Chardin for his work in palæontology; the Thorlet prize to Adolphe Richard.

Special Foundations.—The Lannelongue foundation between Mmes. Cusco and Rück; the Laplace prize to Louis Marcel Massenet; the medal is also accorded to eight other pupils of the École polytechnique; the L. E. Rivot prize between Louis Marcel Massenet, Louis Edmond Séraphin Charvet, Jacques Alexandre Morane, and Alexandre Georges Louis Delattre.

Funds for Scientific Research.—The Trémont foundation to Clément Codron for his book on cutting metals; the Gegner foundation (2000 francs) to Jules Geffroy; the Jérome Ponti foundation to Pierre Mahler for his work on combustibles; the Hirn foundation to Emile Schwoerer for his work in mechanics; the Henri Becquerel foundation to André Danjon for the application of his method of measuring the apparent diameter of the stars; the Charles Bouchard foundation to Georges Bohn for the continuation of his biological work; the Henry Le Chatelier foundation to Paul Riou, Ernest Toporescu, and Paul Mondain-Monval (5000 francs each) for researches bearing on the manufacture of sodium carbonate by the ammonia method, Pierre Lafon (5000 francs) for researches on the enamelling of iron.

University and Educational Intelligence.

THE United States Public Health Service has, in co-operation with the Bureau of Education, collected information as to the present status of sex education in high schools, and the Bureau has published a statistical summary in Bulletin, 1922, No. 14. The proportion of the number of schools giving some sort of instruction in matters pertaining to sex to the number of schools from which returns were obtained (about half of the total number of high schools in the country) is 41 per cent., varying between 17 per cent., in New Hampshire, and 100 per cent., in Utah. Sex education is classified as "emergency"—through lectures or occasional talks by members of the school staff or by physicians, nurses, State health officers, social workers, or ministers, sex hygiene exhibits, pamphlets, etc.—and "integrated," *i.e.* given incidentally in teaching the subjects of the regular curriculum. Although the former method is more frequently resorted to, a large majority of the principals, including those who at present provide no sex instruction, are in favour of the latter. So, evidently, are the authorities of the Public Health Service. These hold the view that "sex education should not be restricted to a certain body of information given at a special time and place, but rather should it be spread over a considerable time and given in various relations." They believe, in short, in breaking down the sex taboo. They point out, however, that few teachers have the combination of mental maturity, poise, sanity, sympathy, accurate knowledge of facts and ability to present them impersonally, and tact, which are requisite for beneficent sex education.

HIGHER education in the maritime provinces of eastern Canada suffers from excessive dispersion of its resources, there being six universities and a technical college doing work of university grade for a population barely exceeding one million. This is partly due to religious particularism. Last year the Carnegie Foundation for the Advancement of Teaching commissioned two experts—Dr. Learned of its own staff and President Sills of Bowdoin College—to visit this area and report on the educational situation with the view of suggesting a constructive policy, for the treatment particularly of the principal higher institutions, all of which had applied to the Foundation for aid. The visits were made in October and November 1921, and the Commissioners presented a report, which has been published as one of the Foundation's bulletins. The report concludes with a recommendation involving complete reconstruction, bringing together into a single university at Halifax, which would include as one of its colleges the Dalhousie University already located there, all the other five universities. It would, the commissioners remark, provide a real solution of the problem and would "prove particularly effective in handling a genuine honors curriculum . . . one of the precious features of English and Canadian universities that should constantly be held uppermost in planning new departures in higher education." The cost is estimated at $4\frac{1}{2}$ million dollars. From an announcement in the *Times* of December 15 it would appear that the numerous difficulties in the way of realising the scheme have been surmounted, representatives of the corporations and governments concerned having arrived at agreement in regard to it.

Societies and Academies.

LONDON.

Linnean Society, December 14.—Dr. A. Smith Woodward, president, in the chair.—W. O. **Howarth**: On the occurrence of *Festuca rubra* in Britain. Representatives of three subspecies, three varieties, six subvarieties, and the forms of Hackel's *F. rubra*, occur in Britain.—H. W. **Pugsley**: British species of Calamintha and a species new to this country. The three recognised British species are said to be *Calamintha ascendens*, Jord., *C. Nepeta*, Savi, and *C. sylvatica*, Bromfield. The new form, first found near Swanage, in Dorset, in 1900, and again in 1912, was identified with *C. bœtica*, Boiss. and Reut., although showing differences in minor features, which were attributed to climatic influence.—Lily **Batten**: The genus Polysiphonia; a critical revision of the British species, based upon anatomy. British species of Polysiphonia show great diversity of habitat. Four main types are distinguishable: (1) Ecorticate plant attached when young by rhizoids developed by longitudinal proliferation of basal siphons. Later, siphons of procumbent branches develop rhizoids, which may have discs at their distal ends, or may ramify among filamentous algæ, or may be swollen to form haustoria. (2) Species having a number of siphons or the beginning of cortication at the base, show elementary aggregation of the rhizoids to form one large disc. (3) Stunted procumbent branches develop at the base of the plant, which produce attachment rhizoids. (4) Corticate species having an upright habit develop a large disc-like expansion by the longitudinal proliferation of basal siphons and corticating cells. The genus is divided into thirteen ecorticate and eleven corticate species, and *P. spiralis* is described for the first time.

Aristotelian Society, December 18.—Prof. H. Wildon Carr in the chair.—Roy Wood **Sellars**: The double-knowledge approach to the mind-body problem. The motives which have worked for the exclusion of mind and consciousness from the brain appear upon examination to have been based upon hasty assumptions. We may call these the epistemological, the categorical, the methodological, and the theological methods. We must determine the reach and character of the knowledge gained by the science of external observation. This beginning is imperative. It seems that this knowledge consists of the critical deciphering by means of "scientific data" of the structure, order, composition, quantity, and behaviour of things and their parts. This is the kind of knowledge we have of bodies, but it is necessarily external. It cannot penetrate to the "filling" or content of being. But in our own case, our consciousness is just such a participation. A careful examination of the situation shows that changes in consciousness are indexes of operations which must also be attributed to the brain. Thus we know the brain in two ways. We should speak of it as the brain-mind. We must conceive the mind more substantialistically than we have done hitherto and make it mean a class of operations, and that which expresses itself in these operations. But we must also re-define consciousness. Leaving aside temporarily the structure of an adult consciousness let us define any element which we call the psychical. The psychical is not a stuff; that was the mistake of association psychology. It is merely a *quale*. Now a *quale* is not self-sufficient. It is a dimension of the content of being which can be given only by participation, not by external knowledge. It is indissolubly one with the responding brain-mind state. Its function is to guide the discharge of this state. Here we are partially on the inside of a high level of causality.

Royal Anthropological Institute, December 19.—Prof. J. L. Myres, vice-president, in the chair.—Cyril **Fox**: The distribution of population in the Cambridge region in early times, with special reference to the Bronze Age. The distribution in Britain of constructions attributable to the Neolithic and Early Bronze Ages suggests that the population was then limited to those areas, mainly upland, which must have been, under natural conditions, largely free from forest. A topographical analysis of finds and remains of all culture periods from the Neolithic to the Saxon in a limited area—the Cambridge region—was undertaken to determine whether this limitation was complete or partial, and when the clearing and occupation of forest areas commenced. The Cambridge region is very suitable for the inquiry since it possesses a wide range of soils and has yielded numerous finds of all periods. The maps exhibited suggest (1) that the chalk belt and the eastern shoreline of the Fens were occupied from Neolithic times onwards; (2) that there was a gradual shift of population from N.E. to S.W., *i.e.* from the West Suffolk heathland to the fertile lands of the upper Cam and Ouse valleys, as agriculture developed; and (3) that the forest uplands were almost entirely unoccupied until the Roman period. The distribution of population in the Bronze Age is, generally speaking, of a character intermediate between that of the Age which preceded it and that which followed, but it presents features of special interest.

DUBLIN.

Royal Dublin Society, December 19.—Prof. J. A. Scott in the chair.—Six papers on the action of the oxides and the oxyacids of nitrogen on aromatic urethanes and ureas at low concentrations of the reacting substances.—(1) **H. Ryan** and **Anna Donnellan**: Diphenylurethane reacted with nitric acid much more slowly than diphenylnitrosamine. At the ordinary temperature it was slowly converted first into 4-nitrodiphenylurethane and afterwards into a mixture of 4·10-dinitro- and 2·10-dinitro-diphenylurethane. Concentrated nitric acid reacted with the urethane forming 2·4·8·10-tetranitrodiphenylurethane and finally sym. hexanitrodiphenylamine.—(2) **H. Ryan** and **N. Cullinane**: *o*-Tolyl-ethylurethane was oxidised by the oxides and the oxyacids of nitrogen yielding o-tolylurethane. The latter substance then underwent nitration, forming successively 4-nitro-2-methyl-phenylurethane and 4·6-dinitro-2-methylphenylurethane.—(3) **H. Ryan** and **Anna Connolly**: Ethylphenylurethane nitrated at the ordinary temperature gives 4-nitro- and 2·4-dinitrophenylurethane. In hot solutions, on the other hand, the urethane, like *o*-tolyl-ethylurethane, underwent oxidation in addition to nitration. In the latter case the products isolated were 2·4-dinitro- and 2·4·6-trinitro-phenylurethane.—(4) **H. Ryan** and **J. O'Donovan**: Phenylbenzylurethane was converted by nitrogen peroxide into 4-nitrophenylbenzylurethane and a trinitrophenylbenzylurethane melting at 110° C. Similar results were obtained by the action of nitric acid at low temperatures on the urethane. At more or less high temperatures and concentrations of the substances a tetranitrophenylbenzylurethane melting at 126° C., a pentanitro derivative melting at 274° C. together with 4-nitrobenzoic acid, 2·4-dinitro-phenylurethane and pentanitrophenylbenzylamine.—(5) **H. Ryan** and **P. O'Toole**: Phenylurea and as-diphenylurea reacted easily with oxides of nitrogen, the former giving nitro-phenols and the latter diphenylamine derivatives; *s*-diphenylurea and triphenylurea under the same conditions gave a dinitro-diphenylurea and a trinitrotriphenylurea respectively. Nitrous acid converted phenylurea and *s*-diphenylurea into their nitroso derivatives. Nitric acid converted phenylurea into phenylurea nitrate, *p*-nitrophenylurea, and 2·4-dinitro-phenylnitrourea. With *s*-diphenylurea it gave mono-, di- and tetranitro derivatives, and with triphenylurea it formed di-, tri- and pentanitro derivatives.—(6) **H. Ryan** and **M. Sweeney**: Phenylmethylurea and nitric acid underwent no change in the absence of nitrous acid. In the presence of the latter acid it was converted into methylaniline, phenylmethylnitrosamine, and then successively into 2- and 4-nitrophenylmethylnitrosamine, 2·4-dinitro- and 2·4·6-trinitro-phenyl-methylamine. With concentrated nitric acid, tetryl was formed readily and in a pure condition from the urea.

Official Publications Received.

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert and the Secretary, Sugar Bureau), 1921–1922. Pp. iv+96+6 plates. (Calcutta: Government Printing Office.) 14 annas.

The University of Chicago. Bulletin of Information, Vol. 22, No. 4: Register of Doctors of Philosophy of the University of Chicago, June 1893–December 1921. Pp. 96. (Chicago: University of Chicago Press.)

Canada. Department of Mines: Geological Survey. Bulletin No. 35, Geological Series No. 42: Relationship of the Precambrian (Beltian) Terrain to the Lower Cambrian Strata of South-eastern British Columbia. By S. J. Schofield. (No. 1966.) Pp. 15. (Ottawa.)

Canada. Department of Mines: Geological Survey. Summary Report, 1921, Part B. (No. 1959.) Pp. 104B. Summary Report, 1921 Part E. (No. 1944.) Pp. 61E. (Ottawa.)

Field Museum of Natural History. Publication 208, Report Series, Vol. 6, No. 1: Annual Report of the Director to the Board of Trustees for the Year 1921. Pp. 75+16 plates. (Chicago.)

Sixtieth Annual Report of the Secretary of the State Board of Agriculture of the State of Michigan, and Thirty-fourth Annual Report of the Experiment Station from July 1, 1920, to June 30, 1921. Pp. 636. (Lansing, Mich.)

State of Connecticut. Public Document No. 24: Forty-fifth Annual Report of the Connecticut Agricultural Experiment Station; Being the Annual Report for the Year ending October 31, 1921. Pp. xi+445. (New Haven, Conn.)

Department of the Interior: United States Geological Survey. Bulletin 722: Mineral Resources of Alaska; Report on Progress of Investigations in 1920. By A. H. Brooks and others. Pp. 266+xiii +3 plates. (Washington: Government Printing Office.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-Verbaux des Réunions. Vol. 28: Procès-Verbaux (Septembre 1922). Pp. 74. (Copenhague: A. F. Høst and Søn.)

Legislative Assembly: New South Wales. Report of the Director-General of Public Health, New South Wales, for the Year 1920. Pp. v+195. (Sydney: J. Spence.) 8*s*. 3*d*.

Diary of Societies.

SATURDAY, JANUARY 13.

GILBERT WHITE FELLOWSHIP, at 2.15.—Visit to the Geological Museum, Jermyn Street.

NATIONAL UNION OF SCIENTIFIC WORKERS (Annual Council Meeting) (at Caxton Hall), at 2.30.

MONDAY, JANUARY 15.

CHEMICAL INDUSTRY CLUB (2 Whitehall Court), at 8.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Lt.-Col. D. Cree: The Yugo-Slavia–Hungarian Boundary.

TUESDAY, JANUARY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. F. G. Donnan: Semi-permeable Membranes and Colloid Chemistry (1). The Theory of Ionic Equilibria and Semi-permeable Membranes.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—Dr. R. Dudfield and others: Discussion on The Registration of Disease.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. C. Dollman: Address.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—C. E. Greenslade, J. E. S. White and others: Discussion on the Need for Suitable Training in Illuminating Engineering.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—F. W. H. Migeod: The Bedde Group of Tribes of N. Nigeria.

ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—Prof. M. J. Stewart and Dr. J. le F. C. Burrow: Malignant Spheno-occipital Chordoma.—Dr. A. J. Eagleton and Miss E. M. Baxter: The Serological Classification of Virulent B. Diphtheriæ.—Dr. C. C. Okell and Miss E. M. Baxter: The Fermentative Reactions of Virulent B. Diphtheriæ.

WEDNESDAY, JANUARY 17.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—W. H. S. Jones: Medical Etiquette in Ancient Times.—Dr. C. Singer: The Hippocratic Oath.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Dr. C. Chree: Aurora and Allied Problems (Presidential Address).

ROYAL SOCIETY OF ARTS, at 8.—C. A. Klein: Hygienic Methods in Painting: the Damp Rubbing-down Process.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—(Annual Meeting).

ROYAL MICROSCOPICAL SOCIETY (Annual Meeting), at 8.—Prof. F. J. Cheshire: The Petrological Microscope and its Optical Evolution (Presidential Address).

THURSDAY, JANUARY 18.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—J. Barcroft: Observations on the Effect of High Altitude on the Physiological Processes of the Human Body.—Prof. E. W. MacBride: Some New Light on the Inheritance of Acquired Characters.—C. F. Cooper: *Baluchitherium osborni* (? syn. *Indricotherium turgaicum*. Borrissyak).—J. A. Gunn and K. J. Franklin: The Sympathetic Innervation of the Vagina.—H. G. Cannon: The Metabolic Gradient of the Frog's Egg.—Basiswar Sen: The Relation between Permeability Variation and Plant Movements.—Dr. H. L. Duke: An Inquiry into an Outbreak of Human Trypanosomiasis in a *Morsitans* Belt to the East of Mwanza, Tanganyika Territory.—Dr. L. Dollo: Le Centenaire des Iguanodons (1822–1922).

LINNEAN SOCIETY OF LONDON, at 5.—Capt. G. H. Wilkins: An Account of the Shackleton-Rowlett Expedition in the *Quest* to the Antarctic Regions.—Miss Helena Bandulska: The Cuticular Structure of certain Dicotyledonous and Coniferous Leaves from the Middle Eocene Flora and Bournemouth.—W. R. Sherrin: A Pocket Herbarium of the British Mosses.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—L. J. Mordell: Lecture on An Introductory Account of the Arithmetical Theory of Algebraic Numbers, and its recent Developments.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major J. D. Rennie: Flying Boats.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—G. H. Nelson: Works Production.

CHEMICAL SOCIETY, at 8.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 8.30.—Dr. J. W. McNee and Dr. A. M. H. Gray: A Chemical and Histological Study of a Case of Sclerema neonatorum.—J. E. A. McDonah: The Use of Manganese as a Chemo-therapeutic Preparation

FRIDAY, JANUARY 19.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—The Earl of Ronaldshay: A Clash of Ideals as a Cause of Indian Unrest.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Dr. L. Turner and J. S. Fraser: Demonstration of Labyrinthitis as a complication of Middle Ear Suppuration.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—L. Pendred: The Problems of the Engine Indicator.—Prof. F. W. Burstall: A New Form of Optical Indicator.—W. G. Collins: Micro-indicator for High-speed Engines.—H. Wood: R.A.E. Electrical Indicator for High-speed Internal-Combustion Engines, and Gauge for Maximum Pressures.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. C. Saunders: Paraffin as Fuel for Marine Motors.—T. H. Sanders: Laminated Springs.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir James Dewar: Soap Films as Detectors: Stream Lines; Vortex Motion, and Sound.

SATURDAY, JANUARY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Walford Davies: Speech Rhythm in Vocal Music (1).

PUBLIC LECTURES.

THURSDAY, JANUARY 18.

LONDON HOSPITAL MEDICAL COLLEGE, at 4.30.—W. A. M. Smart: The Mathematical Basis of Physiological Problems. (Succeeding Lectures on January 25, February 1, 8, 15, 22, and March 1 and 8.)

UNIVERSITY COLLEGE, at 5.30.—J. C. Flügel: The Psychology of Folklore.

KING'S COLLEGE, at 5.30.—Prof. W. Barthold: The Nomads of Central Asia. (Succeeding Lectures on January 25, February 1, 8, 15, and 22.)

SATURDAY, JANUARY 20.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Ancient Egypt and the Aegean Islands.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—Wordsworth.

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Edward Jenner.

ON January 26, 1823, Dr. Edward Jenner, the discoverer of protective vaccination against smallpox, died in his home at Berkeley—a village of Gloucestershire—where he had lived long and practised as a country doctor. For centuries before, smallpox had been a terrible scourge in all countries and vast numbers of people had been swept away in every generation. Based on the observation that one attack of the disease confers, on those who recover, a lifelong immunity, an attempt had been made to imitate the natural disease by artificial inoculation of smallpox, in the hope that the artificially-produced disease might be mild, while creating at the same time a lasting immunity. In England this ancient process of inoculation, or as it was called variolisation, was introduced from Turkey early in the eighteenth century through the instrumentality of Lady Mary Wortley Montagu (1689–1762) and rapidly became widely disseminated. Its disadvantages were twofold. In the first place, it was impossible to gauge how severe would be the effects of the inoculation, which in many cases were severe or even fatal; and in the second place, the disease produced was smallpox which, like the natural disease, was highly contagious, and although the inoculated person might survive and become immune he might disseminate the disease to others.

Jenner's discovery entirely removed these difficulties. Following up the country tradition that milkers who contract cowpox on their hands from infected animals are not capable of contracting smallpox, Jenner made experiments in which matter was taken from infected persons or directly from the cow itself, and he inoculated this into human beings, who developed what is called vaccinia. That these persons become immune to smallpox was shown by Jenner, who subsequently variolated them without being able to induce smallpox. More remarkable still, he showed that vaccinia can be transmitted from person to person in series without losing its properties. Jennerian vaccination is in its essence different from smallpox inoculation as previously practised, for the disease produced is mild and is not contagious.

Jenner's first experiments were made in 1796, and his famous "Inquiry into the Causes and Effects of the Variolae vaccinae" was published in 1798. The process of vaccination was instantly recognised as a great advance and rapidly attained a world-wide dissemination, largely through Jenner's own untiring efforts. A century has established the fact that Jenner's wonderful discovery must rank among the most beneficent known in the history of mankind, and although he has had and still has detractors, the vast mass of opinion of those most entitled to form a judgment of its merits would be in agreement with that of the learned August Hirsch, that " it can only be folly or stupidity that would seek nowadays to minimise or to question the immortal merits of Jenner."

When Jenner died Louis Pasteur was a month-old babe. Thus two great lives were linked: one immortal for a single great empirical discovery, the other destined to carry on the torch and found a science. It is doubtful if even yet the precise relationships of smallpox to cowpox are fully understood, in spite of the great mass of experimental work devoted to the problem during the past hundred years, nor can we point to any great advance in knowledge of the exact nature of the viruses concerned. Opinion, however, has quite definitely crystallised on one point, namely, that cowpox—now a great rarity in nature—is no spontaneous disease of the cow but is simply the bovine response to accidental infection with smallpox virus or vaccinia, conveyed by the hand of the milker. The evidence on which this statement is based rests fairly securely (1) on the successful results of experimental transference of variola to the cow, (2) the benign nature of the resultant lesions, and (3) the undoubted immunity to smallpox which the bovine disease confers when retransferred to man. It is true that, in the past century, schools of dualists and unicists have engaged in acrimonious discussion, but the spoils of the battle rest with the latter. Cowpox or vaccinia is simply an attenuated form of smallpox, and were there no smallpox there would be no naturally occurring cowpox. Further, with none of the other eruptive lesions in the domestic animals (horse-pox, sheep-pox, etc.) can smallpox be brought into similar relationship. These others are independent infections.

The diversity of response to one and the same virus by various animal species has been a fruitful field of speculation since Pasteur's time, and we know that Pasteur's chief concern was to expand Jenner's discovery so as to secure, for immunisation purposes, some strain of other living viruses, which, with the property of virulence removed or at least depressed, would yet adequately perform the function of immunising against the fully virulent variety. In swine erysipelas, Pasteur claimed to have secured the desired attenuation by passage through another species—a result on all fours with Jenner's observation as we now understand and interpret it. These normal immunities and explanations of them will doubtless for long be the subject of research, and in the present issue we take the opportunity of reprinting the main part of a recent address by Prof. J. C. G. Ledingham, who discusses the present state of knowledge in relation to normal immunity of species to various infections, and the factors on which such immunities have been alleged to depend.

Science in Secondary Schools.

THE committees appointed to consider the position of Natural Science, Modern Languages, Classics, and English in the educational system of Great Britain have now formulated their reports, and the Board of Education has issued a circular (No. 1294, December 6, 1922) in which some of the consequences of these reports are discussed. One of these is the question of the amount of time to be given to the teaching of individual subjects, and as the result a time-table has been provisionally drawn up which provides for 35 to 37 teaching periods of 45 minutes each per week in school, and not including time necessary for exercises and preparation. The Science Committee considers that not less than six periods per week should be given to that subject. This means about three-quarters of an hour per day, and no science teacher will be disposed to consider that too much for boys between the ages of 13 and 16.

The main point for consideration relates to the subjects which should be taught in the course of the school life, say altogether eight or nine years. As usually arranged, the course begins with nature study, followed by physics and chemistry, and no time is provided for subjects like astronomy and the elements of geology, which are necessary for the apprehension of common terrestrial phenomena. In considering such a question, regard should be had to the objects to be kept in view in teaching natural science at school. The first consideration should not be the usefulness of the applications of science, but its purpose should be to furnish the mind and supply some kind of clue to the phenomena of the physical world into which man is introduced at birth.

It is further necessary to cultivate habits of attentive observation and careful reasoning, so that some at least of the delusions to which all are exposed should be less deadly. It is, however, not necessary or desirable that all the subjects referred to should be taught at the same time, and they need not be taught with the same degree of thoroughness. Much general information may be imparted in a well-chosen series of lessons in nature study, while chemistry and physics, begun later, should be carried on to the end of school days. Many illustrations of facts relating to other subjects may be introduced in a less formal manner, not as school lessons but with the aid of the lantern and a sort of popular lecture, not to be followed by any examination or other test which only frightens young people away.

The circular from the Board of Education contains the remark that with " four periods of 45 minutes in the morning and three in the afternoon for five days per week, a full week consists of thirty-five periods." But it will be found that these thirty-five periods for instruction include two for physical exercises, two for manual work, two for drawing, and one for music, or seven periods altogether, and some of these may be interrupted or replaced temporarily without loss. Thus when games are properly organised they may replace physical exercises, and manual work may, to some extent, be replaced by experimental work in the physical or chemical laboratory at the suitable age. These are questions which will not be settled immediately, and with others they might well be considered at a meeting of the Science Masters' Association, especially with reference to the question as to how many of the science periods should be given to physical and how many to biological studies, the latter being often totally neglected.

Archæology and Technology of Carpets.

Hand-woven Carpets: Oriental and European. By A. F. Kendrick and C. E. C. Tattersall. Vol. 1. Pp. xi+198. Vol. 2. Pp. xi+205 plates. (Benn Bros., Ltd., 1922.) 105*s.* net.

THE pile carpet, though now an essential element in European domestic economy, is of foreign origin. Weaving is one of the most ancient and widespread of arts, and to produce a pattern by interlacing continuous threads is a natural development from it. From this to using threads of different colours is an easy transition. But to set the threads in a vast number of short lengths upon end, and to pack them so tight that they keep that position, entails so much skill and uses so much material that they can only have been originally produced in response to very special conditions.

Those conditions are encountered in the life of the nomads of Central Asia. The extreme changes of temperature in that part of the world, the demand of the nomadic life for portable and non-conducting fabrics, and the ample supply of wool available to these herdsmen, fit in with the archæological findings. Central Asia is thus designated as the home of the pile carpet. Recent excavations in that region have brought to light small fragments of such ancient carpets. Most curiously, however, the earliest complete pile carpet known is of European manufacture. It was prepared toward the end of the twelfth century in a nunnery at Quedlinburg in the Harz Mountains, and represents the well-known medieval theme of the "Marriage of Mercury and Philology." Oriental literary influence was very strong in Europe at that period. The art of carpet-weaving may well have come to Europe at this time along with "Arabian" science.

The earliest carpet of which a detailed description has come down to us, was made for the Persian Chosroes (531–579), and his successors used it until the last Sassanian king, Jazdegerd (632–651), pursued by the Arabs, was assassinated at Merv. The Persians are said to have had two loves, gardens and drinking, and this carpet was used for the drinking feasts in the stormy winter season when it was impossible to stay in the garden. The carpet was designed to portray a garden and was called "The Spring of Chosroes." It was woven as though planted with trees and spring flowers, intersected by brooks and pathways. Several very ancient Persian carpets, with a design which recalls that of Chosroes, have survived.

India was much later in the field than Persia, and does not appear to have produced pile carpets until the sixteenth century. Pile carpets were devised to meet the needs of colder climates than India, and in such climates suitable wool for making them can more easily be grown. The export trade in Indian carpets began in the seventeenth century, and has now reached very considerable proportions. After the middle of the nineteenth century carpet-knotting was begun in the jails, and many of these "jail-carpets" are now on the market. They are mostly copied from old patterns.

In Turkey the carpet industry was stimulated in the early part of the sixteenth century, when Selim I. in 1514, and again Suleiman I. in 1534 entered Tabriz and carried off craftsmen to Asia Minor. Much earlier, however, an export trade between the Anatolian ports and Europe—especially Venice—had been opened up and carpets began to come westward. Few of these have survived, but a number are represented in the works of Dutch and Italian artists, Jan van Eyck, Memlinc, Van der Goes, Holbein, Ghirlandajo, Pinturicchio, and others.

The first European country to develop a carpet industry was Spain, which was producing carpets of similar design to the Turkish in the fifteenth century. In England little was known of carpets until at least a century later. Paul Hentzer, a German who came to London in 1598, states that Queen Elizabeth's presence-chamber at Greenwich was strewn with hay. Even rush-matting, though used by the French from the beginning of the fifteenth century, does not seem to have come into general use in this country till the reign of James I. Pile carpets, however, were beginning to be imported into England from the East about the middle of the sixteenth century, and the actual making of them here was not long delayed. A carpet represented on a fine plate in this volume has in the middle the arms of England with the initials of Queen Elizabeth and the date 1570.

Before the end of Elizabeth's reign the English

Turkey Company had begun direct trading with the Eastern Mediterranean, and carpets were more easily obtained. Some of these were copied more or less faithfully in England. A "Turkey" carpet of English manufacture is in the Victoria and Albert Museum bearing the inscription, "Feare God and keepe his commandements made in the yeare 1603." Some light is thrown on the manufacture of such carpets by a chapter in Hakluyt's "Voyages": "Certaine directions . . . to M. Morgan Hubblethorne, Dier, sent into Persia 1579," where we read: "In Persia you shall finde carpets of coarse thrummed wool, the best of the world, and excellently coloured: those cities and towns you must repair to, and you must use means to learn all the order of the dying of those thrums, which are so dyed as neither rain, wine, nor yet vinegar can stain. . . . If before you return you could procure a singular good workman in the art of Turkish carpet-making you should bring the art into this realm."

These magnificently illustrated volumes provide a complete key not only to the history of carpetry, but also to the technology and identification of carpets both ancient and modern. The text is lucidly and attractively written. The illustrations are largely drawn from the collection at the Victoria and Albert Museum, to which have been added many of the plates from Neugebauer and Orandi's "Handbuch der orientalischen Teppichkunde" and other sources. The authors, printers, and publishers are to be congratulated heartily on this singularly attractive production.

CHARLES SINGER.

Vitalism and Anti-Vitalism.

Grundlagen einer Biodynamik. von Prof. Dr. Johannes Reinke. (Abhandlungen zur theoretischen Biologie. Herausgegeben von Prof. Dr. Julius Schaxel, Heft 16.) Pp. v+160. (Berlin: Gebrüder Borntraeger, 1922.) 12*s.*

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. 1 Abteilung, 1 Teil: Cytologie. Band 1: Zelle und Cytoplasma. Von Henrik Lundegårdh. Pp. xii+193-402. (Berlin: Gebrüder Borntraeger, 1922.) 24*s.*

L'Organisation de la matière dans ses rapports avec la vie: études d'anatomie générale et de morphologie expérimentale sur le tissu conjonctif et le nerf. Par Prof. Jean Nageotte. Pp. vi+560+4 planches. (Paris: Félix Alcan, 1922.) 50 francs.

THESE three books all deal with the fundamental question of the relation of the activities denoted by the term "life" to the constitution of the matter in which they are exhibited. When living matter is analysed (and necessarily killed in the process) it is found to consist of proteids, fats, carbohydrates together with certain metallic salts. What has made this mixture "alive"? Is there, as Verworn supposed, a living substance *par excellence* for which the other materials in protoplasm constitute an environment? Verworn named his hypothetical substance "biogen," and "life" was supposed to consist of the characteristic reactions of this substance with surrounding materials; reactions by which the biogen molecule was partially destroyed, but as the result of which a residue was left from which a new biogen molecule was reconstituted, and so the continuity of life was maintained. If, on the other hand, the difficulties involved in the supposition of a specific biogen molecule are too great to be overcome, life may be supposed to consist in the mutual reactions of a characteristic mixture of substances, and no single substance viewed apart from the others can be considered alive. In this case all depends on the specificity of the mixture—in a word, *on the physical structure of the living matter.* We may phrase it in another way if we say that life depends on the *juxtaposition in a definite way of unlike substances.* But how is this physical structure maintained? Is there a reduced copy of the frog in the frog's egg? That no typical physical structure will explain living phenomena has been clearly proved by Driesch. No imaginable "constellation of parts" would survive the changes described by Driesch in his account of his experiments and yet yield the same typical result which was given by the original mixture.

Now the authors of the three books before us all agree in rejecting the biogen theory: the first falls back with some hesitation and the use of different words on an explanation which is closely akin to the entelechy of Driesch, the second ignores the difficulties raised by the view that protoplasm is a mixture, but Prof. Nageotte vehemently denounces vitalism. The only reason, he asserts, that we believe in such an empty concept is the unfortunate circumstance that we ourselves are alive, and our life is the "accidental" result of our organisation—a phrase which "gives us furiously to think." It is not quite clear how on Prof. Nageotte's view science itself can exist, and how an "accidental result of our organisation" can either acquire or impart "knowledge" of phenomena outside us. But as we shall see, Prof. Nageotte, while like Balaam he begins with the intention of cursing vitalism, is led like the prophet to bless it altogether—although he is not conscious of the fact.

Prof. Reinke's book is an attempt to make a comprehensive survey of the characteristic peculiarities of animals and plants and so to deduce general laws governing life. The laws which he formulates are three in number, namely, (1) All life begins from pre-existing life; (2) There is a tendency to the restitution and maintenance of typical form in spite of its continual destruction by catabolism; (3) Psychic phenomena are only manifested in connexion with living material. But, according to Reinke, it is by no means allowable to attribute a "psyche" to all forms of living matter; it is a contradiction in words to imagine a "psyche" where there is no evidence of sensation; and so he is unable to attribute feeling to plants. Since, however, the protoplasm of plants obeys the same laws as that of animals, and its activities are not explicable on any conceivable theory of physical structure, he invents the word "diaphysical" to denote the basis of these activities. (It is a pity that he seems to be unacquainted with the work of Sir Bahadur Bose.) "The peculiar combination of 'elementary mechanisms' in the organism constitutes its being and is of diaphysical nature." He pours scorn, which we think is deserved, on "materialistic vitalism." By this phrase is meant the attempt to escape from the impasse created by the impossibility of explaining life by physical structure, through the invention of an imaginary series of units many thousands of times smaller than the electron, to which are attributed imaginary properties so as to account for living phenomena. He states, "By assimilation as by other chemical processes (cf. the formation of chlorophyll and enzyme) we only obtain lifeless substances. The 'vitalising' of these substances takes place only by their insertion in the framework of protoplasm"—and this essentially vital step he terms "epiplasty."

As might be expected, Prof. Reinke encounters the Mendelian "gene" and in our opinion takes it far too seriously. A gene he considers to be a vital unit "which controls energy, material, and pattern; out of which definite form develops." It is becoming every day clearer *that a "gene" is not a definite unit of structure at all, but simply the measure of the amount of pathological damage which the hereditary substance has undergone.* It is a measure, in a word, of the "imperfection of regulation." The differences between two allied natural races are not measurable in genes but in different adaptations; the overwhelming majority of Mendelian mutations arise under the unhealthy circumstances of domestication: they are nearly all recessive to the parent strain, from which they differ not only in special diagnostic marks but in weaker constitutions; in the few cases where they are dominant to the normal form they are generally so virulently pathological that when crossed with their like the results are lethal.

It seems to us after careful perusal that all that Prof. Reinke states as to the peculiarity of living processes has been said many times before. Reinke's influence of "the whole on the parts," and his "dominants" are simply Driesch's entelechy in other language—while so long ago as the early 'eighties Tyndall stated that it was not the nature of the forces manifested in living matter but their combination which constituted the miracle of life. The importance of the book consists in the tardy recognition, by a leading botanist, of the impossibility of explaining life by physics and chemistry alone.

Prof. Lundegårdh's "Zelle und Cytoplasma" is one of a series of text-books devoted to the elucidation of the anatomy of plants, and consequently it is concerned almost exclusively with the cytology of vegetable cells.

It is beautifully illustrated, and so far as plants are concerned the information contained in it is well up-to-date; but the author seems to be less well informed on the most recent advances in animal cytology. It is a characteristic botanical point of view to attempt to deny, as he does, the all-importance of the nucleus in the transmission of hereditary qualities. According to him the nucleus derives its importance only from containing in it some links in the chain of chemical reactions which make up metabolism. Nature's critical experiment in the formation of the animal spermatozoon is ignored by him. When we find that in animals the sole contribution of the father which contains the basis of all his hereditarily transmissible qualities is a condensed nucleus, the question as to the function of the nucleus seems to be decisively answered.

Lundegårdh agrees with Reinke in considering protoplasm to be a mixture of various colloids of different chemical composition. He emphasises the enormous variety of chemical changes which such a constitution would entail, and with the perpetual change from sol to gel and *vice versa*; he shows that the visible structure must be continually altering and that the granular theory of the constitution of protoplasm propounded by Altmann, the filar theory of Flemming, and the foam-work theory of Bütschli, may all be to a certain extent true under certain conditions, but that under other conditions there may be no visible structure at all, and that the living material may present the appearance of a homogeneous fluid. He, like Reinke, will have nothing to do with a hypothetical ultramicroscopical constitution of invisible units as an explanation of life. He condemns with equal severity the supposed difference between "idioplasm" and "somatoplasm," and he sharply criticises the unthinking acceptance of what can be seen in preserved specimens as a true indication of what exists during life. It is here that his arguments would be very much reinforced by a better acquaintance with the results obtained by Chambers and Seifert in the microdissection of living cells. The attempt to constitute the mysterious mitochondria into permanent cell-organs is equally opposed; he asserts that they are secondary formations, and that in the growing point of Anthoceros the youngest cells are devoid of them but that they appear in the older cells.

The great defect of Lundegårdh's exposition seems to us to be his failure to show how a mixture of substances with their consequent reactions can be an explanation of the typical character and persistence of living phenomena. When a mixture of substances is enclosed in a test-tube definite reactions are set up which progress towards a state of eventual equilibrium, and an end-state is reached with a mixture of different substances and in different proportions from that with which we started. In protoplasm, on the contrary, the typical nature and proportions of the mixture must somehow be maintained even in spite of increase in quantity—and these facts cannot be explained by any purely physical and chemical analysis.

Prof. Nageotte's book is widely different from the other two. Although it professedly deals with the relation of matter to life, it really consists of the record of a series of fascinating experiments on animal grafts. The results obtained are new and startling, but they are illustrated by what can only be termed an extremely bad series of figures. These are prints from photographs, hazy and very insufficiently lettered, and we can only deplore that such good work should be misrepresented by such feeble illustrations.

We have said that Nageotte begins by condemning vitalism. He states that the essential peculiarity of living things is not their chemical constitution, but a certain order in what he terms the micellar structure, the micellæ being supra-molecular complexes. Agreed; but it is precisely the genesis and maintenance of this order which is the inexplicable fact in living things. Nageotte even tries to prove that there is a transition between dead proteid and living protoplasm, and as the principal support of his anti-vitalistic attitude is based on this supposed transition we must examine it in some detail. He proceeds as follows: Some dog's blood collected in a test-tube is enclosed in a capsule of collodion open at one point. This is introduced into the peritoneal cavity of another dog, the open end of the capsule being in contact with the peritoneum. At the end of eight days the capsule is found to be completely encysted: the blood has clotted by the formation of radiating fibres of fibrin, but the opening of the capsule is plugged by a cork of fibrous tissue richly supplied by the host's blood-vessels. Now Nageotte maintains that the regularly arranged bundles of fibres of the fibrous tissue are produced by the gradual transformation of the radiating fibrin fibres; that the immigration of fibroblasts (*i.e.* connective tissue cells) is secondary, and finally that these elementary fibres can grow by intussusception from the fluid surrounding them. The whole of the supposed transition is based on the arbitrary inclusion of intercellular substance in the term living matter. Nageotte protests vehemently against what he terms the "exoplasmic theory," *i.e.* the view that this substance is the product of the secretion or bodily alteration of the exoplasm of the connective tissue cells; he terms it "the internal medium." But if he were an embryologist instead of merely a surgeon and an anatomist, he would see clearly that historically there is no other possible origin for his internal medium except the secretion of the surrounding cells: and he himself admits that subsequent changes in it only take place under the influence of living cells in the neighbourhood. Whether this influence is exercised, as he supposes, by the emission of ferments or by the production of secretion is a minor matter. If in company with the vast majority of histologists we regard the intercellular material as dead, then the validity of the supposed transition is destroyed.

Among the most startling of Nageotte's results is the discovery that it is possible to graft into a living animal a piece of connective tissue which has been preserved in alcohol or formaline. A piece of tendon thus treated introduced under the skin of the ear of a rabbit becomes invaded by the surrounding "fibroblasts"; its bundles of fibres become connected up at their ends with the surrounding connective tissue, and thus definitely incorporated in the skeletal framework of the ear. When a piece of dead cartilage is similarly treated still more curious results ensue. The neighbouring "fibroblasts" surround it and form a new perichondrium. These cells invade the capsules of the cartilage laid open by the section. These invading tongues burrow into the cartilaginous substance, forming cavities which they surround by newly formed *bone*, although there is normally no bone whatever found in the rabbit's ear.

If a segment of an artery of one dog preserved in alcohol be inserted between the cut ends of the artery of another dog, it becomes clothed with an endothelium: its layers of elastic and connective tissue become continuous with those of the artery of the other dog at both ends; and it becomes provided with new smooth muscle fibres, which appear from the transitional forms observed to be modifications of connective tissue cells.

We pass now to Nageotte's experiments with cut and regenerating nerves and nerve grafts. As all are aware, there have been two leading theories of nerve structure. According to the older, nerves are formed by chains of cells the protoplasm of which becomes differentiated in place into nervous fibrils. According to the newer and almost universally accepted view, first firmly established by Ramon y Cajal, the nerve fibre or axon throughout all its length is the outgrowth of a single cell, the neurone or neuroblast. When it is cut the distal portion of the fibre, being separated from the influence of the nucleus contained in the neuroblast, undergoes "Wallerian" degeneration: the proximal stump grows out again into the old sheath, and so the fibre is regenerated. According to Nageotte, both theories are true. The axon, or, as he terms it, the "neurite," is the outgrowth of the neuron, but it can only grow along chains of ectoderm cells which constitute the sheath of Schwann. The only exception to this rule is when the axon reaches the ectoderm itself; in this medium it grows as a "naked" fibre. The medullary sheath belongs to the axon itself; it is produced by the confluence of mitochondria, and it is broken up and absorbed when the axon degenerates. When a nerve has been cut and the axons have degenerated, there ensues a rapid proliferation of the bands of ectoderm cells both at the proximal and distal sides of the cut: these bands form networks, and both cut ends may assume the aspects of swollen knobs. The upper of these is termed by Nageotte the "neurome," the lower the "gliome." The neurome becomes invaded by new axons; many of these get into lateral branches of the ectodermal network and never reach their destinations, but when neurome and gliome meet, as they eventually do, some axons penetrate the lower part of the nerve and so function is restored.

Nageotte has also established the remarkable fact that if a piece of a nerve be cut out and employed as a subcutaneous graft it becomes the centre of a nodule of firm, tough connective tissue, evidently showing that the cells of Schwann emit some substance which acts as a stimulus to the production of this kind of tissue. For this reason, when a long portion of a nerve has been lost and a graft is necessary to restore continuity, a graft of dead artery or tendon is often more effective than one of dead nerve.

The outstanding result of Nageotte's researches seems to us to be that the connective tissue cells have the power of acting as bone-cells, cartilaginous cells, "fibroblasts," or even smooth muscle fibres, according to the circumstances in which they are placed; that in Driesch's words the prospective fate of a cell is determined not by its nature but by its position—that "Ein jedes jedes kann" and this is a vitalistic conception, not a chemical or physical one.

E. W. MACBRIDE.

Early Mathematical Instruments in Oxford.

Early Science in Oxford. By R. T. Gunther. Part 2: Mathematics. Pp. 101. (London: Oxford University Press, 1922.) 10*s.* 6*d.* net.

THREE years ago a very interesting exhibition of early scientific instruments in Oxford was held at the Bodleian Library. A small printed list or catalogue of the exhibits was prepared at the time by Mr. Gunther, to whom all those interested in early scientific instruments are much indebted for bringing together the various early examples existing in the colleges of the University of Oxford, and making them available for inspection. It was intended that this small catalogue should form the basis of a more comprehensive work dealing with the history of science at Oxford, chiefly on the instrumental side. The first instalment (Chemistry) of this larger work was printed as a booklet in 1920 and afterwards published (see NATURE, March 3, 1921, p. 13). The second instalment, dealing with mathematics, has now been issued.

The stated object of Mr. Gunther's work is "to draw attention to such material objects of value as still remain to us, with a view to their better preservation, and to reviving the memory of the clever men who really helped science forward by the invention of practical methods, and by the cunning of their craftsmanship."

The first part of the booklet consists of "Notes on Early Mathematicians." One of the first mathematicians connected with Oxford was Daniel of Morley, who resided there in the year 1180, but went to the mathematical school at Toledo to complete his studies, and afterwards returned to this country as a teacher. The best known mathematician of this early period was the Yorkshireman, John of Holywood (Sacrobosco), who died in 1244. In the fourteenth century Richard of Wallingford, Thomas Bradwardine, John Maudith, Simon Bredon, John Ashenden, William Rede, and others, raised Oxford mathematics to a high level, and at that time "Oxford could boast more Mathematicians than any other country in Europe."

During the next century the study of mathematics was at a low ebb; in the middle of the century the only mathematical subjects required at Oxford for the master's degree in the *quadrivium* were the first two books of Euclid and the astronomy of Ptolemy. Cuthbert Tonstall (1474–1559) and Robert Recorde (1510?–1558), the only two English mathematicians of note during the first half of the sixteenth century, commenced their studies at Oxford, but found that they could continue them better at Cambridge, and

Mr. Gunther regards them as "the founders of what has been the most brilliantly successful mathematical school in the world."

Considerable space is given to Recorde's work, and it is remarked that "although Recorde was a Fellow of All Souls, yet two years back his name was quite unknown there, and not one of his numerous printed books is in the College Library." It has been possible, however, from existing documents, to reconstruct the catalogue of Recorde's private library, and this is given. The first section closes with references to the work of Edmund Gunter (1581–1626), William Oughtred (1574–1660)—not an Oxford man, but a clever mathematician who "appears to have given private tuition in mathematics to many Oxford men,"—Christopher Wren (1632–1723), Seth Ward (1617–1689), John Wallis (1616–1703), and Nathaniel Bliss, who was Savilian professor of geometry from 1742 to 1765.

The second part consists of a descriptive list of early mathematical instruments belonging to the University and colleges of Oxford, including some allied instruments in the collections of the Royal Society, Mr. Lewis Evans—whose large and valuable collection, at present exhibited in the Bodleian, is now offered as a gift to the University (see NATURE, December 9 and 16, 1922, pp. 783, 828),—and a few others. Of special interest is the seventeenth-century oak chest—*cista mathematica* (Fig. 1)—in the Bodleian Portrait Gallery, which originally contained the various demonstration models of the Savilian professors, as detailed in the 1697 catalogue of the Bodleian Library. In spite of its three different locks, the only portions of the original equipment now remaining are two small beechwood spheres. Other interesting objects described are the "Circles of Proportion" of Oughtred, and the instruments from the Orrery collection in Christ Church College. This collection, which consists of elegant examples of the work of John Rowley and others at the beginning of the eighteenth century, has been "shut up in a cupboard" since 1731, the year in which it came to Christ Church as part of a bequest of Charles Boyle, fourth Earl of Orrery.

FIG. 1.—Cista Mathematica. By the courtesy of the Librarian of the Bodleian Library.

The excellent condition of most of these instruments affords ample testimony to the efficiency, in this instance, of the "shut cupboard" method of preservation. Unfortunately, this happy result is exceptional, the more usual experience being of the Mother Hubbard type. Such collections, formed so that posterity may be able to see actual examples of the fine work performed by makers in the past, in some way or other often dwindle, disperse, or disappear. Various causes—war, fire, the carelessness or ignorance of a custodian, exigencies of space required for other purposes, the transference of such objects from one department to another concerned only with modern developments and with no sense of the high value of actual early instruments as original documents—tend to produce such a result. Experience in all countries shows that the safest and most efficient way to preserve such specimens of the work of men who have played a big part in the development of modern civilisation is to exhibit them under the proper conditions of security afforded by a national museum, so as to be available continuously for inspection. A Museum of Science should be rich in such objects, which testify in a very real manner to the state of advancement in past times in the art of constructing scientific instruments.

The last part of Mr. Gunther's book consists of short notes, arranged in chronological order, on mathematical instrument makers from the latter part of the sixteenth to the early part of the nineteenth century. We look forward with interest to the publication of the next instalment, which will deal with astronomy at Oxford.

Our Bookshelf.

Principles and Practice of Butter-Making. By Dr. G. L. McKay and Prof. C. Larsen. Third edition, largely rewritten. Pp. xiv+405. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 15*s.* net.

The volume under notice is the third edition of one of the best-known American books on commercial butter-making; it deals with the subject with great thoroughness, and contains information which has been collected from the best sources. The introductory chapters give an account of the composition of milk, its secretion, and the conditions which influence secretion. Next come the properties of milk, and these are followed by an account of the changes which milk undergoes when heated. In an account of the peculiarities of butter fat, s ress is laid upon the great value of this fat in nutrition, owing to its content of the fat soluble vitamin A. There are chapters on the enzymes and bacteria found in milk, and the causes which induce variations in the percentage of fat.

Sampling and testing of milk and cream, both from the point of view of fat content and suitability for butter-making, are dealt with, and the best creamery methods for the estimation of fat in butter are given, while there are also chapters dealing with modes of payment for milk and cream delivered to the factory.

The various types of separators and the best means of separating milk naturally occupy a prominent place, and the preparation of the cream for churning is fully discussed. Excellent chapters are written upon the churning, working, washing, and finishing of butter from the point of view of creamery practice. Packing and marketing of butter; defects and their causes; judging and grading; storing, particularly cold storage (descriptions of the plant are also given), are all dealt with fully.

Handbook of Commercial Geography. By Geo. G. Chisholm. New edition. Pp. xvi+824. (London: Longmans, Green and Co., 1922.) 25*s.* net.

All geographers and economists will welcome this new edition of Mr. Chisholm's well-known work with its scrupulous accuracy of detail. The previous edition was published eleven years ago: the present, a ninth edition, was almost ready when war broke out in 1914. The necessary delay in publication has enabled Mr. Chisholm to revise the book according to the present condition of the world. The book has been reset throughout, which has allowed the incorporation in the proper places in the text of the matter in several of the introductions of earlier editions, and the chapter on trade routes. The section on the British Isles has been extended considerably. Several new maps have been added including rainfall and actual temperature charts. The valuable statistical appendices have been revised to 1913 and increased in number. A new feature is a long list of alternative geographical names. While the book has grown, its well-known features remain unchanged, and few works of reference are better arranged or indexed than this standard volume on commercial geography. It is a monument of painstaking research, clear thinking, and encyclopædic knowledge, indispensable not only to every serious student of geography and economics, but also to all engaged in trade and commerce.

The Canary Islands: Their History, Natural History, and Scenery: An Account of an Ornithologist's Camping Trip in the Archipelago. By D. A. Bannerman. Pp. xvi+365+pl. (London: Gurney and Jackson, 1922.) 30*s.* net.

The problems presented by insular faunas and floras are of the greatest interest both to the student of geographical distribution and to the geographer. Chapters V. and VI. of this rather uncomfortably heavy book deal respectively with the affinities and origin of the Canarian flora, the modes of dispersal of the trees and plants, the distribution of animal and bird life in the Canary Islands, and some problems which they suggest. The author gives numerous examples of the influence of complete isolation on the differentiation of birds no longer able to interbreed with the continental stock from which they sprang; and in some cases, *e.g.* that of the Fuerteventura bustard, is able to suggest how the local conditions may have contributed towards the selection of geographical subspecies. The chapters on the origin, geology, and physical characteristics of the islands are convenient summaries for the general reader, while references to larger works and original papers will enable those who wish to consult the first-hand authorities.

Les Maladies parasitaires des plantes (Infestation-Infection). Par M. Nicolle et J. Magrou. Pp. 199. (Paris: Masson et Cie, 1922.) 8 francs.

Two doctors of the Pasteur Institute have collaborated on the production of a text-book chiefly for the benefit of the medical profession. The ground covered is very wide, including diseases due to both insects and fungi. Part I. deals largely with gall formation, with short chapters on acarids and nematodes. The remaining parts give an outline of the diseases due to phanerogams, fungi, and bacteria, with a general discussion of such questions as virulence of attack and resistance to disease. The complete absence of illustrations is a very serious drawback, even though it be considered necessary on account of cost. A further disadvantage is the lack of a bibliography, which would partly have compensated for the very brief treatment of each subject. In other ways the book is well produced and will serve a useful purpose in making information on plant diseases available to medical men.

Clocks and Watches. By G. L. Overton. (Pitman's Common Commodities and Industries Series.) Pp. ix+127. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 3*s.* net.

Mr. Overton has given us a most useful and interesting volume, describing the gradual evolution of timepieces from the early water clocks, through the balance clock, down to the modern pendulum clocks and chronometers. There are many illustrations, and the various methods of compensating for temperature are described in plain non-technical language. In addition there are details, probably new to many readers, relating to the striking mechanism of clocks and of repeater watches. The latter are stated to have come to an end when the introduction of lucifer matches made it easy to read an ordinary watch at night. There is a chapter dealing with the artistic side of the subject, and describing several clocks and watches of special interest and beauty. It is altogether a book that will appeal to the general reader quite as much as to those specially interested in time-determination. A. C. D. C.

Anthracite and the Anthracite Industry. By A. Leonard Summers. (Pitman's Common Commodities and Industries Series.) Pp. x + 126. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 3*s.* net.

THIS book seems to be a combination of a scientific manual and a coal-dealer's propaganda circular. With some useful information about anthracite, we find other matter—on p. 26 a statement that in 1921 the South Wales coal-owners were losing 25,000,000*l.* a year because of "unwanted young men—'hotheads' and agitators" in the mines—an example of "what the industry is up against"; on p. 69 we have a series of testimonials in the approved style, and "tourist facilities in the beautiful anthracite district" in Chapter II. The printing of advertisements on the reverse of the title-page is also distracting. When information about anthracite is encountered in the book it proves interesting, but some patience is required to find it. "Tar," we are told on p. 112, "also contains chemicals, such as carbolic acid and saccharine."

Polarity. By Geoffrey Sainsbury. Pp. 48. (London: The Favil Press, Peel Street, W. 8., 1922.) 3*s.* 6*d.*

MR. SAINSBURY's artistically printed little book consists of a series of short essays on sex, religion, education, society, and ethics. The point of view of the author is unusual and independent, and it demands that the reader's mind should free itself from many placidly accepted concepts. Polarity, the author thinks, has never been adequately considered, as man invariably tries to bring the problem of life and all attendant problems down to a single issue. Polar conflict is to be seen everywhere, and innumerable problems hinge upon this relationship and to none of this type can there be any final answer. There is also a plea for a willingness to see knowledge from a more general, instead of the extremely specialised, point of view. There will be many readers who will dissent from the views here set forward, which will certainly stimulate thought.

Man—The Animal. By Prof. W. M. Smallwood. Pp. xv + 223. (New York: The Macmillan Co.; London: Macmillan & Co. Ltd., 1922.) 12*s.* net.

PROF. SMALLWOOD's little book is interesting but confessedly "popular," and therefore fraught with the difficulties that are inseparable from all "popular" presentations. Its object is to summarise the discoveries of recent years, to indicate some of their relations to the more fundamental problems of man's physical existence, and to give a deeper insight into the characteristics which man has in common with all life, and which exercise a profound influence on his entire existence. The chapters on reproduction, heredity, the problem of learning, and biology and progress are especially well done. The whole book, though not absolutely free of error, is worth reading, and will be especially appreciated by readers possessed of biological knowledge.

Chemistry and its Uses. A Text-Book for Secondary Schools. By W. McPherson and W. E. Henderson. Pp. viii + 447. (London: Ginn and Co., 1922.) 7*s.* 6*d.* net.

THE text-book before us is intended for use in American high-schools, and would probably be very suitable for that purpose. It is written from the point of view of the patriotic American, and naturally refers principally to American conditions. There are some reproductions of portraits of well-known chemists. Each chapter is provided with exercises, and a rough equality of division is adopted between pure and applied chemistry (including organic chemistry, treated very superficially). There are numerous illustrations of labelled bottles: even assuming that these contained what is represented when they were photographed, the value of the pictures is not at all clear. Surely it is not intended that they shall replace actual acquaintance with real substances? The actual text is clear and accurate, so far as it was examined, and the book would interest English teachers.

Chemistry for Beginners and Schools (with Glossary). By C. T. Kingzett. Fourth edition. Pp. vii + 237. (London: Baillière, Tindall and Cox, 1922.) 5*s.* net.

THE continued demand for Mr. Kingzett's book indicates that it is serviceable to numbers of readers. It is clearly written, and contains many interesting experiments. The glossary will also be found useful by beginners; surely, however, "lixiviate" is commoner than "lixurate" (p. 212)? The section on "Force and Energy" (pp. 34-52) requires revision. It is very much out-of-date in parts, and not up to the standard of the rest of the book: the statement that "electricity, like heat and light, is a form of force" (p. 45), although it may have been true for Faraday, is not so to-day. The book is scarcely suitable for schools, as it provides no systematic course—the experiments are introduced at random.

Concrete and Reinforced Concrete. By W. N. Twelvetrees. (Pitman's Common Commodities and Industries Series.) Pp. x + 137. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) 3*s.* net.

THE general reader will find a great deal of interesting matter in this book, which is explanatory and practically free from calculations. Sufficient is given to make clear the nature of the materials employed and their combination, and the author has included a number of examples of finished work which convey a very good impression of the extent to which concrete and reinforced concrete have been employed, and of their possibilities. There are some historical notes, from which we gather that the ancient Egyptians were thoroughly familiar with concrete, as is proved by a fresco in the temple of Ammon at Thebes, depicting hieroglyphically the making and use of concrete in the year 1950 B.C.

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.]*

On the Missing Element of Atomic Number 72.

SINCE Moseley's discovery of the fundamental laws of the X-ray emission, it has become quite clear that the most simple and conclusive characteristic of a chemical element is given by its X-ray spectrum. In addition, Moseley's laws allow us to calculate very accurately the wave-lengths of the X-ray spectral lines for any element in the periodic table, if those of the elements in its neighbourhood are known. Taking into account that the presence of a very small proportion of a definite element in any chemical substance suffices to give a good X-ray spectrum of this element, it is quite evident that for the eventual discovery of any unknown element X-ray spectroscopy, especially as it has been developed by Siegbahn, represents the most effective method.

In the *Comptes rendus* of the Paris Academy of Sciences for May 22, 1922, Dauvillier announced the detection by means of X-ray spectroscopy of the element 72 in a mixture of rare-earth metals. This element was identified by Urbain with a rare-earth element, which he called celtium, the presence of which he had previously suspected in the same sample. For different reasons, however, we think that Dauvillier's and Urbain's conclusions are not justified. It appears from Dauvillier's paper that at any rate the quantity of the element 72 in the sample, if present, must have been so small that it seems very improbable that the element 72 should be identical with the element which in former papers Urbain claims to have detected in the same sample by investigation of the optical spectrum and of the magnetic properties. The only lines which Dauvillier claims to have detected are the lines $L\alpha_1$ and $L\beta_2$, both of which he finds to be extremely faint (*extrêmement faible*). The wave-lengths he gives, however, for these lines are about 4 X.u. (1 X.u. $= 10^{-11}$ cm.) smaller than those which are obtained by a rational interpolation in the wave-lengths tables of Hjalmar and Coster, for the elements in the neighbourhood of 72.

From a theoretical point of view it appears very doubtful that the element 72 should be a rare-earth. It was announced in 1895 by Julius Thomsen from Copenhagen that from general consideration of the laws of the periodic system we must expect between tantalum, which in many compounds possesses 5 valencies, and the trivalent rare-earths, a tetravalent element homologous to zirconium. The same view has also recently been put forward by Bury on the basis of chemical considerations, and by Bohr on the basis of his theory of atomic structure. It is one of the most striking results of the latter theory, that a rational interpretation of the appearance of the rare-earth metals in the periodic system could be given. For these elements, according to Bohr, we witness the gradual development of the group of 4-quantum electrons from a group containing 18 electrons into a group of 32 electrons, the numbers of electrons in the groups of 5- and 6-quantum electrons remaining unchanged. Bohr was able to conclude that in the element lutecium (71) the group of 4-quantum electrons is complete, and we consequently must expect that in the neutral atom of the next element (72) the number of electrons moving in 5- and 6-quantum orbits must exceed that in the rare-earths by one. The element 72 can therefore not be a rare-earth but must be an homologue of zirconium.

In view of the great theoretical importance of the question we have tried to settle it by an experimental investigation of the X-ray spectrum of extractions of zirconium minerals. We have succeeded in detecting six lines which must be ascribed to the element 72 (in Siegbahn's notation $L\alpha_1$, α_2, β_1, β_2, β_3, and γ_1). The complication was met that the lines $L\alpha_1$ and α_2 lie almost exactly in the place corresponding in the spectrum to the zirconium $K\alpha_1$, and α_2, lines in the second order. Difficulties which might arise from this fact may easily be avoided by keeping the tension on the tube between the critical tension of the zirconium K-lines (18,000 volts) and that of the L-lines of the missing element (10,000 volts). Besides, the relative intensity of the $K\alpha$ lines is so different from that of the two $L\alpha$ lines that any ambiguity is already thereby excluded. Not only the $L\alpha$ lines but also the lines $L\beta_1$, β_2, and β_3 were, as regards their mutual distance and their relative intensity, in exact agreement with the expectation. The values which we obtained for the wave-lengths of the six mentioned lines all agree within one X.u. with those found by interpolation. Between our values for the lines $L\alpha_1$ and $L\beta_2$, and those published by Dauvillier, however, there exists the discrepancy referred to of about 4 X.u. (in general for other elements which have been measured by Dauvillier and by Coster the discrepancy is never more than 2 X.u.). Exposures under different conditions as well as a thorough discussion of the plates showed that the new lines found during our investigation cannot be ascribed to the first or higher order spectrum of any other known element. Our provisional results are: $L\alpha_1 = 1565{\cdot}5$; $\alpha_2 = 1576$; $\beta_1 = 1371{\cdot}4$; $\beta_2 = 1323{\cdot}7$; $\beta_3 = 1350{\cdot}2$; $\gamma_1 = 1177$ X.u. More accurate and complete data as well as photographs of the spectrum will soon be published.

In a Norwegian zirconium mineral the new lines were so intense that we estimate the quantity of the element 72 present in it to be at least equal to one per cent. Besides we investigated with low tension on the tube a sample of "pure zirconiumoxyde." Also with this specimen the $L\alpha$ lines were found, but very faint. It seems to be very probable that ordinary zirconium contains at least from 0·01 to 0·1 per cent. of the new element. Especially the latter circumstance proves that the element 72 is chemically homologous to zirconium. Experiments are in progress to isolate the new element and to determine its chemical properties.

For the new element we propose the name Hafnium (Hafniae = Copenhagen).

D. COSTER.
G. HEVESY.

Universitets Institut for teoretisk Fysik,
Copenhagen, January 2.

Continental Flotation and Drift.

THE theory that the continents have shifted their positions during geological time and, possibly, are still in motion has lately excited much discussion. The principal obstacle to its acceptance is the difficulty of adducing a force adequate to bring about the movements. Many years ago Osmond Fisher ("Physics of the Earth's Crust" p. 339) ascribed general continental movements of this kind (accounting for the Atlantic rift, etc.) to the disturbance of the Pacific basin due to the genesis of the moon, on Darwin's well-known theory. Lately, Wegener has brought forward much evidence in favour of continental movements. But I do not think he has discovered any adequate source of the motion. The *polefluchtkraft* is too feeble; it is purely meridional in direction and is inconsistent with the existing distribution of the land. It is probably ineffective. A differential soli-lunar attraction on the emergent features of the continents is obviously inadequate. The fact is Wegener works out the theory on the basis of a westerly drift of the continents. In doing so I think he is in error. An adequate force appears available provided an easterly drift is postulated; and so far as I can see the theory grows in probability when examined from the new point of view.

According to Sir George Darwin, the tidal effects of sun and moon acting on "a stiff yet viscous planet" ("The Tides," p. 277) must produce a retardation of the surface crust relatively to the interior. He states that this is speculative as regards the earth; but this was written twenty-five years ago. The great fact of the isostatic compensation of the continents, proving their flotation in a viscous magma, was not then supported by such strong evidence as Hayford and others have since adduced. I assume that the differential motion exists (or formerly existed) and that the floating continents possess a slightly less rotational velocity than the deeper parts of the underlying magma, the velocity of which continues to increase downwards until a more rigid interior is reached.

The consequence of this assumption is that the eastern velocity of every land area on the globe depends to some extent upon its downward penetration into the sustaining magma. A continent upon which a great geosynclinal loading is progressing becomes acted upon by the faster moving layers and is exposed to a force which is continuous and relentless, and the intensity of which depends on the area and depth of the protuberance. Whether the resultant motion of the continent will be due east, relative to the surface crust, or whether it will take up a turning or rotational motion, will depend on the location of the applied force. If excentric a rotational movement must ensue. If uniform over the continental area—as in the case of a great "revolution" or oceanic invasion—the drift will be towards the east.

According to this view, America did not leave Europe and Africa but was left behind by them. Their increased easterly velocity was, possibly, ascribable to the great Laramide submergence of South Europe, South Asia, and North Africa. (The tidal effect is greatest in equatorial regions.) In a similar manner New Zealand left Australia: the force in this case being plainly referable to the isostatic compensation demanded by the lofty ranges of New Zealand. So also Ceylon was torn from Peninsular India; the fracture line of the eastern Asiatic coast was produced, etc.

As regards mountain elevation it is evident that, while from the present point of view mountain building is in every case ultimately referable to tidal forces, mountains may develop in different circumstances. They may, in central continental areas, be conditioned partly by magmatic pressure from beneath, partly by crustal pressure. In such a case as the western mountains of America the magmatic pressure eastwards must be the principal agent. The continental movement gives rise, in this case, to a depression of the bordering ocean floor—a "wake." But, again, continental movements may give rise to mountain chains by the direct pressure between land masses. In this manner the Himalayan chains probably originated. The force arising out of the compensation required by the great and lofty central plateaus of Asia sufficiently accounts for a turning movement around the more stationary features of Peninsular India and the Arabian Plateau. This is in harmony with the current view that the fold-mountains of Asia were diverted by the resistance of those massive earth blocks. J. JOLY.

Trinity College,
Dublin, December 31.

SINCE my return from the Falkland Islands a few months ago I have followed with great interest the course of the discussion in the columns of NATURE which has ensued upon the publication by Prof. Wegener of his revolutionary views on the flotation and drifting of continental masses. During my recent geological survey of the Falkland Islands I was very greatly impressed by the extraordinary similarity of the geology of the Islands to that of Cape Colony. The geological succession comprises rocks ranging in age from Archæan to Permo-Carboniferous, although rocks of Cambrian, Ordovician, and Silurian age appear to be absent. The oldest rocks closely resemble some of the Archæan rocks of Cape Colony; and from the Devonian to the Permo-Carboniferous the lithological and palæontological succession is practically identical in the two areas. The post-Triassic dolerite dykes of the Falklands are also very like the intrusions of the same age in Cape Colony. The east and west folding so evident in the southern part of Cape Colony makes the most conspicuous feature in the Falkland Islands. The only notable point of difference in the two areas is that whereas in Cape Colony the lowest division of the Cape System (Devonian), namely the Table Mountain Series, is much folded, the corresponding rocks in the Falkland Islands have escaped such disturbance and lie almost horizontal, or with only a gentle dip, over an area of many square miles. The equivalents of the middle and upper members of the Cape System (Bokkeveld Series and Witteberg Series) are, however, intensely folded in the Falkland Islands.

From the orthodox point of view one has to believe in the persistence, in minute detail, of a stratigraphical sequence representing the passage of a great period of geological time, across the 5000 miles of ocean which separate Cape Colony from the Falkland Islands, and, in face of the array of facts marshalled into such an orderly and effective host by Wegener and again by Du Toit, this becomes, on a sudden, an unexpected strain upon one's faith.

In discussing the ice-fields of Gondwanaland in his very interesting paper, "Land Connections between the Other Continents and South Africa in the Past" (*S. Afr. Journ. Sci.*, pp. 120-140, Dec. 1921), Dr. Du Toit states that in the Falkland Islands the centre of origin of the ice is unknown. I was able, during my survey of the Islands, to note that wherever the glacial tillite at the base of the Permo-Carboniferous sequence was adequately exposed it was always possible to collect a varied assortment of rocks occurring as erratic boulders in the deposit, and certain types, such as pegmatite, a coarse granite, and a pink quartzite, never failed to occur. The one and only exposure of Archæan rocks in the Colony occurs at Cape Meredith, the southernmost point of West Falkland, and when I examined that area I readily recognised the pegmatite, granite and quartzite occurring there as similar to the ubiquitous boulders of the tillite. Subsequent microscopic examination confirmed the identity of the rocks.

With regard to the direction of the striæ on glaciated surfaces underlying the tillite, I never came across a really convincing exposure, but in a few places on both East and West Falkland I noted, on the smoothed surface of the quartzite beneath the tillite, what I regarded (although with some doubt) as glacial striæ, and in every case the markings ran about N. and S. (magnetic). The evidence suggests movement of the ice from south to north, but we have no knowledge as to whether there did not exist, in Palæozoic times, an exposed mass of ancient rocks to the northward of the present Islands.

HERBERT A. BAKER
(late Government Geologist for the Falkland Islands).

Wood View, Grosmont Road,
Plumstead Common, London, S.E.18,
January 3.

The Determination of *p*H of Microscopic Bodies.

NEUTRAL red has the almost unique property of being both an intra-vitam stain and a fairly good indicator. It has also low salt and protein errors, as Homer has shown (1917, *Biochem. Journ.* 11, p. 283).

If therefore cells are stained with neutral red, the colour of the stain as observed with the microscope enables one to judge roughly the *p*H within the cell.

Working on certain marine protozoa, I have found a method of greater accuracy than that of merely judging the colour as seen down the microscope. The method is simple and, so far as I am aware, has not been recorded before.

A series of tubes containing solutions of increasing *p*H is made up in the ordinary way, and a few drops of neutral red are added as indicator. A stout cardboard strip is taken and holes are cut in it at intervals so that the strip will carry the series of tubes (each tube fitting tightly).

The strip with the tubes hanging freely below it is now suspended in the window. With the aid of the microscope condenser the series is focussed sharply in the plane of the object which is being examined.

The appearance down the microscope now consists of the stained object and by its side the image of the series of tubes: both are seen against the same background of sky. By simply tilting the mirror the images of successive tubes of different *p*H can be brought into juxtaposition with the object examined. In this way the *p*H of the stained body can be determined by direct comparison.

I have found that the *p*H determined by the above method can be checked roughly as follows. The mirror is tilted so that the image of one of the tubes forms a background against which the object is seen. In these circumstances the object is illuminated by light of the particular quality corresponding to the colour of the tube. A succession of tubes is used in this manner as a background for the object.

When the background transmits the same quality of light as the stained object, the latter appears relatively light and transparent: this occurs when the colour of the object and the background correspond to the same *p*H. If the object is illuminated by light from a tube of higher or lower *p*H, the object appears darker owing to the fact that the light transmitted by the background is not exactly of the same quality as the light transmitted by the object. The *p*H of the background tube against which the object appears lightest corresponds to the *p*H of the object.

It must be admitted that the colour change with the *p*H in the case of neutral red does not render the latter an ideal indicator for the second method, but the effect is quite good enough to be used as a check. Perhaps a better intra-vitam indicator will be discovered in the future, and in that case the method might be developed to a fair degree of accuracy.

In all this work a good achromatic condenser is essential, for the diaphragm must be widely open in order that the colours of both the object and the image of the tubes may be well defined.

When the light is bad or when artificial light is used, the definition of the colours is greatly increased if the light is first filtered through a dilute solution of copper sulphate. Using this filter, the red tint due to the presence of acid appears darker and is more easily seen in lightly stained bodies.

C. F. A. PANTIN.

The Marine Biological Laboratory,
Citadel Hill, Plymouth, December 14.

Divided Composite Eyes.

IT would appear from Mr. Mallock's letter (NATURE, December 9) that our knowledge of the Aleyrodidæ or "White Flies" is not so exact as it might be. This, however, takes too pessimistic a view of the situation. Whilst, undoubtedly, much remains to be done, even with some of the British species, the specific limits of those to which he refers are quite well known to students of the group. Indeed, as a result of my own researches I have been able, in recent communications to the *Entomologist* and the *Vasculum*, to assign our British species to no fewer than four distinct genera, Aleyrodes, Tetralicia, Aleurochiton, and Asterochiton, and the forms mentioned by Mr. Mallock reveal themselves as comprising two genera and three species, namely, *Aleyrodes proletella* L., *A. brassicæ* Walk., and *Asterochiton vaporariorum* West.

Clearly, as no hint is given that any of his insects were bred from *Chelidonium majus*, the figures given cannot represent *A. proletella* as indicated by the legend; they must be referred either to *Aleyrodes brassicæ* or to *Asterochiton vaporariorum*. If *A. brassicæ* is the insect intended, then as a larva it feeds on cabbage, as a pupa it lacks well-developed dorsal papillæ, and in the perfect condition has spotted wings with the median nervure appearing as a short spur. On the contrary, the larvæ of *Asterochiton vaporariorum* can be collected from any of the plants enumerated, its pupæ have dorsal papillæ, and its imago possesses immaculate wings displaying no trace of the media.

To the latter insect belongs the notoriety gained by the so-called "White" or "Tomato" fly during the past twenty years. Unfortunately, this Aleyrodid, although a native of neotropical regions, is so adaptable in its food habits as to be nearly polyphagous and, furthermore, has acquired the habit of wintering at ordinary air temperatures even in this rather bleak locality on the north-east coast. A colony with which I was experimenting in 1921 successfully withstood all the frosts of the winter of 1921–22, the first brood of the present season emerging in May.

A further point I cannot understand is Mr. Mallock's comparison of the life-cycle of the Aleyrodidæ with that of the Aphididæ. So different are the two cycles that I feel sure that some mistake has arisen here. In every detail of their structure and life history their affinities lie rather with the Psyllidæ (particularly with some of the Triozæ possessing scale-like larvæ) or toward the Coccidæ.

Finally, I should like to point out that I am preparing a monograph of the British Aleyrodidæ and should therefore be extremely glad to receive species of the group, more especially if they are accompanied by their respective larvæ and pupæ.

J. W. HESLOP HARRISON.

Armstrong College, Newcastle-upon-Tyne,
December 12.

I AM obliged to Dr. Harrison for remarking on the mistake in my letter in NATURE of December 9 where in one place "Aphides" was written instead of "Coccidæ." The specific name *proletella*, placed under the outline sketch in Fig. 1 *a*, was given on the authority of a well-known entomologist to whom specimens were sent for identification. Dr. Harrison would name this *brassicæ*.

With regard to the number of genera and species to which he refers, the present tendency seems to be to multiply both unnecessarily. Among the various Aleyrodids which I examined there appeared to be considerable variation, and it was possible to collect from the same plant specimens differing in size from large to small through many gradations and having wing spots either well marked or nearly evanescent.

The difference between "species" and "variety" is one of degree, but specific difference may be claimed for races which have so diverged that a fertile mixed race cannot be produced from them. Whether this condition is satisfied in any particular case can only be determined by rather laborious trials, but in the absence of evidence of this kind it would be more correct, and certainly more convenient, while noting small differences (which may be constant in certain circumstances and localities) to treat them as varieties.

A. MALLOCK.

9 Baring Crescent, Exeter,
December 21.

Science and Armaments.

I DESIRE to direct the attention of readers of NATURE to a matter which I think to be of importance. During the war of 1914–18 a great number of scientific men, other than those in the medical service, were engaged on work which was devoted entirely to military ends.

Since the armistice there has been some tendency, not unnatural perhaps, to confuse this war work with other researches carried out directly in the service of science. In the Science Library, South Kensington, cheek by jowl with works on atomic theories or relativity, are found such books as one on the organisation of the Army Signal Service, and another on poison gas warfare which adopts most successfully the language of a scientific text-book. In the publications of certain learned societies, nominally concerned with purely scientific aims, are found descriptions of instruments and investigations of almost purely military interest. The collection of war material at the Crystal Palace is shortly to displace the priceless collection of historical apparatus and instruments from the Western Galleries of the Science Museum; the instruments are to go into storage, in a place where they will be inaccessible to the general public, for an indefinite period.

The lamentable implication seems to be that the development of armaments now holds a recognised place as one of the worthiest aims of science, but that is a doctrine which, I trust, is still very much open to question. It is more probable that we simply lack good taste and a proper appreciation of relative values.

I venture to suggest that science would be best served by keeping these things separate. If necessary, let the Government extend a military museum to house such of the material from the War Museum as possesses real interest from the military point of view; it should not be allowed to displace a single instrument from the historical collections. Let us also refrain from filling our library shelves with matter of the kind previously indicated. So may the temple of science be kept free from echoes of human quarrels.

The example of the British expedition sent, in spite of the war, to test the Einstein effect has often been quoted as an outstanding example of the wonderfully dispassionate internationalism of science, but it scarcely bears comparison with the events of a hundred years ago when Davy, taking Faraday as his assistant, travelled to Paris to lecture during the height of the Napoleonic wars. We have gone far since those days—In which direction?

L. C. MARTIN.

Imperial College of Science, South Kensington.

Waterspouts.

WITH reference to the letter from Dr. Hale Carpenter (NATURE, September 23, p. 414) describing an interesting waterspout seen over Lake Victoria, a letter has been received in the Meteorological Office from Mr. H. E. Wood, of the Union Observatory, Johannesburg, describing the development of a cloud pendant seen by him on the afternoon of November 19, 1922. The following extract from Mr. Wood's letter describes the occurrence:

"The day was a particularly calm one, the morning was hot with a fairly clear sky, but early in the afternoon there were many cumulo-nimbus clouds in the sky. I noticed particularly the uniformity in the base-level of all the clouds. Just about 3 P.M. I noticed a little pendent cone under one of these clouds and, having seen a waterspout here once before (in 1910) thought this might become one and decided to watch it. The waterspout developed rapidly and I got Mrs. Wood to make a series of drawings of it. Unfortunately the waterspout was rather too far away for photography—it would have been very small taken with an ordinary camera and I had no telephotographic lens available. The interesting feature of the waterspout seemed to me to be the detail of the earth-end (as shown in Fig. 1 reproduced

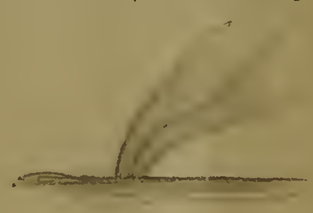

FIG. 1.

from a sketch made at 3.15 P.M.): there was a well-marked "core" surrounded by a less dense sheath. It did not rain in the vicinity of this spout until some time afterward; so that the lower part would probably consist of dust. Later we saw a series of waterspouts in the same vicinity. We estimated (when this particular cloud became an active thunderstorm) that the distance of the waterspouts was about 8 miles and hence that the length of the column or height of the cloud base was about 3700 feet."

The phenomenon noted by Mr. Wood is very similar to that noted by Dr. Hale Carpenter, except that in the present case the part shown in the sketch is probably due mainly to dust raised by the whirl. It is possible, however, that the greater density of the central core is due to condensation of water vapour.

D. BRUNT.

Meteorological Office, Air Ministry,
December 23.

I STOOD watching the effects of an ordinary small whirlwind when a Swahili volunteered the information that similar phenomena were at times to be seen over the sea, but that, in those cases, what one saw was God (*Muungu*) drawing a whale (*nyamgum*) aloft.

Most Swahilis have only a shadowy conception of what a whale is; to them it is a great snake which devours men and even boats. When God is angry with one of these beasts, he lets down a rope by which the monster is caught and drawn struggling to heaven. H. E. HORNBY.

Mpapua, Tanganyika Territory,
November 21.

The Cause of Anticyclones.

IN NATURE of December 23, 1922, p. 845, Mr. W. H. Dines points out that the main features of the pressure distribution of the atmosphere are of a permanent character, and, strange to say, the great areas of low pressure are over the cold poles, while the two belts of high pressure are on both sides of the equator in latitudes 30° or thereabouts; and, so far as the troposphere is concerned, the atmosphere is warm over areas of high pressure. Mr. Dines remarks, "The difficulty should be faced and not ignored."

At the Royal Society, on November 23 last, I had the pleasure of hearing a paper read by Lindemann and Dobson, who have succeeded in determining the temperature of the upper atmosphere (stratosphere) by observations of the luminosity of meteors. They estimate that at a height of 60 km. the temperature of the air is in the neighbourhood of 300° Abs.

In a paper communicated to the *Phil. Mag.* (vol. xxxv., March 1918, p. 233) I gave a diagram showing the probable temperature of the atmosphere between the poles and the equator up to heights of 70 km. This diagram was constructed by plotting the temperatures ascertained by sending up self-registering balloons, and extrapolating for greater heights. At the poles the temperature arrived at was about 285° Abs. at 60 km. In the paper referred to I concluded that the stratosphere over the poles and equator is much hotter than it is over the high pressure belts at latitudes 30° N. and S. of the equator —20° C. or more—and suggested that the winds of the earth are very largely affected by these differences of temperature.

The temperature values found by Lindemann and Dobson showed considerable variations when the results obtained by one falling star were compared with another. I would suggest that the several results they obtained be plotted on a diagram, the ordinates being temperatures at 60 km. and the abscissæ barometric pressures. Knowing the time and position of each falling star, the pressures could be obtained from meteorological charts. My suggestion was that the upper atmosphere is hotter over low pressure areas than it is over high pressure areas.

R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey,
December 27.

Soil Reaction, Water Snails, and Liver Flukes.

IN NATURE of November 25, p. 701, Dr. Monica Taylor mentions that the distribution of *Limnæa truncatula* in S.W. Scotland is very local, being rare or altogether absent from certain districts in which sheep are known to be infected with liver flukes. In such districts *L. peregra* is found infected with perfectly developed cercariæ of *Fasciola hepatica*. Free active cercariæ of the latter are also found.

In NATURE of December 23, p. 845, Mr. R. Hedger Wallace directs attention to the prevalence of liver fluke disease in the Swansea valley, where rough pastures have been limed. He asks, "Does liming a wet sour pasture make it more congenial to the water snail?"

For the past year, as occasion permitted, we have been engaged upon the study of the distribution of snail species in relation to the hydrogen ion concentration of the soil and water. A very striking limitation is found for certain species, and but few are found in the more acid habitats. Thus, over quartzite at pH4·8, nothing but a few Hyalinias could be found, whereas around pH7 numerous species exist, including *L. truncatula*. Fewer species are found at pH8, but those that do are often in great numbers, *Helicella caperata* and more especially *H. virgata*. Upland peat soil is usually close to pH4·6, and rough pastures may be between that and pH5·4 or somewhat over, so it seems highly probable that liming such land, by bringing it to the neighbourhood of pH7, does make the conditions more favourable for the snails concerned in the transmission of the disease.

In cases where certain sheep in a flock are infected, it would seem advisable to drive the flock to the most acid soil available, provided it is strongly acid, for in such a site the infected sheep will not be able to infect others, and so the disease may be stamped out or reduced in amount.

Where the neutral or slightly acid soil which appears to favour the occurrence of liver fluke disease is wanting, transference to chalk or limestone soil, at about pH8, may perhaps be equally effective; but it must be remembered that, owing to leaching by rain, the steep places in such districts may be less alkaline, or even acid.

It is very desirable that the limits of distribution of *L. truncatula* and *L. peregra* should be defined in relation to the reaction of the soil and water, and the writers would be glad to receive samples of soil from infected and uninfected localities.

The distribution of snails in relation to soil reaction is similar to that of plants, and it may be added that there is a widespread belief in the west of Ireland that liver fluke disease is caused by eating a certain plant found in fields where the disease has been known to occur. The Gaelic name of the plant was mentioned to one of us, but, unfortunately, it has been forgotten. The distribution of the plant may serve as a guide to the distribution of the snails in question.

W. R. G. ATKINS.
M. V. LEBOUR.

Marine Biological Laboratory, Plymouth,
December 28.

Amber and the Dammar of Living Bees.

IN the issue of NATURE for June 3, 1922 (vol. 109, p. 713), a letter is published from Prof. T. D. A. Cockerell, of the University of Colorado, on "Fossils in Burmese Amber." This refers mainly to amber obtained from the amber mines in the Hukong Valley, which I visited in February 1921. In that letter Prof. Cockerell, after investigating the insects preserved in specimens of the amber, agrees with me in placing the age of the amber-bearing beds as the earlier part of the middle Eocene, there being no doubt that the Nummulites found by me are actually *Nummulites biaritzensis* d'Arch.

In the second part of his letter, however, Prof. Cockerell introduces a new problem. In addition to the specimens from the Hukong Valley amber mines, he mentions a number of beads of extremely pale and pellucid amber which he afterwards received from Mr. R. C. J. Swinhoe, of Mandalay. These contained well-preserved insects all different from those identified in the amber from the Hukong Valley mines. Mr. Swinhoe was uncertain whether these beads were Burmese amber or whether they had been imported from China. Prof. Cockerell, after identifying the included insects in this pale amber, came to the conclusion "that this light amber (or copal) is of very recent origin, not earlier than Pleistocene, and contains a fauna which doubtless consists mainly (at least) of species still living." The point of great interest to me is that among these representatives of still living species he found "a small bee which seems not to differ at all from the common living *Trigona læviceps* Smith."

Now *Trigona læviceps*, or, as it is sometimes called, *Melipona læviceps*, is the actual, or at least chief, source of the common resinous substance known as Dammar (Burmese—Pwé-nyet). These bees build in hollows within trees, crevices among rocks, etc., and line the interior surfaces of their nests with a massive resinous substance. This resinous substance is the common Dammar of the Burmese bazaars, and is used largely by the Burmese for the caulking of boats. Hooper (*Rep. Labor. Ind. Mus.*, 1904–5, 23-4) reports on two samples examined by him. It seems to be the general opinion that it is largely constructed by the bees from the oil and resin of Dipterocarpus.

It seems to me, therefore, that the light amber beads examined by Prof. Cockerell may quite likely be fossil Dammar, or in other words, Dammar deposited in crevices and holes in the earth or rocks by Melipona, which has afterwards been buried up and entombed and fossilised. The inclusion of a specimen of the actual bee in this fossil Dammar would be not only possible but highly probable if such is the case.

Although I do not know the place from which the pale Chinese amber comes, I offer the above suggestion as to its origin; and from what I saw of the actual occurrence of the Burmese amber in the Hukong Valley amber mines it seems to me not unlikely that some such method may be the explanation of its origin also, though in this case one would not expect the depositing insect to be the same species as that depositing Dammar at the present day.

MURRAY STUART.
Indo-Burma Oilfields, Ltd., Thayetmyo,
Burma, December 8.

Modern Psilotaceæ and Archaic Terrestrial Plants.

WITH the establishment of an early Devonian group of vascular cryptogams showing fundamental resemblances with the modern Psilotaceæ, the controversy over the essentially primitive or reduced nature of the latter family may be said to be closed. In spite of important points of difference, the resemblances appear to suffice to link the Psilotaceæ with the most archaic types of terrestrial plants of which the structure is known at all adequately. The object of the present note is to record another piece of evidence pointing in the same direction.

As Kidston and Lang say, "In its anatomy Asteroxylon is most closely comparable with the Psilotaceæ and with Lycopodium" ("Old Red Sandstone Plants," etc., Part III., 1920, p. 667). So far as the leafy shoot is concerned, however, the hollow stele of the Psilotaceæ, as generally described, does not readily fall into line with that of Asteroxylon or Lycopodium, in which the centre is occupied by a more or less compact mass of cauline xylem. It is therefore of some interest to note that one or more cauline strands devoid of protoxylem are normally present in the pith of *Tmesipteris Vieillardi* Dang., an erect terrestrial form said to be endemic in New Caledonia. The medullary strands generally arise from the ring of peripheral strands in the transitional region between the rhizome and aerial shoot, and when traced distally as a rule end blindly in the pith, although they sometimes merge into the peripheral strands. They show a good deal of variation in the degree of their development, generally not extending very far up into the leafy shoot, but their presence is a normal feature of the anatomy.

In this respect, therefore, *Tm. Vieillardi* facilitates the comparison of the Psilotaceæ with the Devonian genus Asteroxylon, and also serves to strengthen their lycopod affinity, already established on other grounds. In a paper read before the Cambridge Philosophical Society (see NATURE, June 13, 1918, vol. 101, p. 299) I directed attention to this and other features, in view of which I regarded *Tm. Vieillardi* as the most primitive member of the Psilotaceæ; but the discovery of Asteroxylon adds point to the conclusion there arrived at. It is natural to regard the poorly developed and variable medullary xylem of *Tm. Vieillardi* as a stage in the disintegration of a once continuous and solid cylinder of cauline xylem extending throughout the length of the axis; the hollow steles of *Tm. tannensis* and of Psilotum would thus form the next stage in the reduction. This reduction within the group, however, need not affect the essentially primitive nature of the Psilotaceæ as a whole.

I must add that medullary xylem had previously been recorded in Tmesipteris on two occasions: (i.) by C. E. Bertrand, 1885, "Recherches sur les Tmésiptéridées," p. 248, Fig. 215 (A); and (ii.) by P. A. Dangeard, *Le Botaniste*, 1890–91, p. 17, Pl. XI. Fig. 1. But the nature of the material at their disposal (herbarium specimens) appears to have precluded a detailed investigation by the French authors; they make only a passing reference to the feature in question, apparently considered by them to be only a rare occurrence.

B. SAHNI.
Botany Department,
University of Lucknow, India,
December 7.

Action of Cutting Tools.

IT is true, as Prof. Andrade points out in NATURE of December 30 (vol. 110, p. 876), that I am "not altogether familiar with the work that has already been done on the subject": indeed it is obvious. And after glancing through the 82 pages of bibliography at the end of Prof. E. C. Bingham's "Fluidity and Plasticity," I feel certain that I shall remain in this state. Tresca's Memoirs, however, are very well known among engineers, and they have been quoted and digested by several writers of engineering text-books and papers, but it is doubtful if the practical use of cutting tools has been much influenced by Tresca's work, beautiful and interesting though it is.

The important problem which faces the user of cutting tools is the preservation of the cutting edge under heavy loads, and while Taylor's work is the outstanding contribution on the matter, Mr. Mallock's explanation of the influence of friction on the upper surface of the tool is invaluable to the machinist. The study of the shaving, while perhaps uninteresting to the physicist, is vitally important to the engineer, for, on one hand, the machinist watches the behaviour of the tool very much in the shaving, and, on the other, the plastic flow on the back of the shaving, which produces flat-backed shavings from round-nosed tools, is probably a principal cause of the undesirable heating of the tool, and an important factor in the frictional phenomena involved.

H. S. ROWELL,
Director of Research.
Research Association of British Motor and
Allied Manufacturers,
15 Bolton Road, W.4, January 4.

Natural Resistance and the Study of Normal Defence Mechanisms.[1]

By Prof. J. C. G. LEDINGHAM, C.M.G., F.R.S.

CERTAIN aspects of immunity have long baffled the experimental pathologist and are certain to receive in the future more adequate consideration when the fundamentals of the science of immunity, like those of all experimental sciences, come to be relaid.

The phenomena to which I would direct attention come in the category of what is known as natural immunity or natural resistance—a subject vast and many sided—and I would propose to consider simply what amount of light has been thrown on the elucidation of certain well-known instances of natural immunity to bacterial infection, by the study of the bactericidal functions of body cells and fluids. The infection I would choose for illustrative purposes is that of anthrax, largely because it has been in connexion with the peculiar and fascinating divergencies of susceptibility exhibited by animal species towards this infection, that defence mechanisms have been tested with a view of their elucidation.

When one considers the enormous output of literature on immunity which, since the beginning of the century, has followed regularly the discovery of some new defence mechanism, one has reason to feel that some sufficient explanation might have been vouchsafed us for the existence of these peculiar resistances, but as I hope to show you now, there is no subject in immunity which has been so persistently and yet so inadequately explored. The discovery of a new immunity mechanism has led in the first instance, as a rule, to its intensive exploitation for diagnostic or therapeutic purposes, and rightly so in the main. Some mechanisms have lent themselves more readily than others to such exploitation. Many again have failed to attract anything but a passing fancy and they have been promptly forgotten or ignored, while the great flood of freshly gathered facts and fictions has continued to roll on uninterrupted. And yet if it be true, as I believe, that knowledge is best grasped in its historical setting, then surely these half-forgotten theses must claim the attention of the serious investigator. With the colossal mass of literature on pathology, bacteriology, and immunity on our shelves, it is no easy task to comply with the historical method, but I maintain that the ambition should ever be to build truly on the historical past so that when the time comes for synthesis the old bricks may simply require relaying. The real expert must aim at being a man of vision with a working knowledge of and a pride in a glorious historical accomplishment. A mastery of technique is often, in my opinion, of much less relative value.

Natural immunity remains a dark corner in our edifice. Immunology as an essentially experimental science has undoubtedly gained its chief triumphs in the domain of acquired immunity. It has sought with marked success not only to imitate the immunity that is seen to follow successful combat with the actual disease naturally contracted, but also to transfer the chief bearer of that immunity from the immune subject, be it recovered human or immunised horse, to the acute case. In some notable instances we seem to know with certainty what we are doing in so acting, that, for example, the passive fluid injected represents simply so many units of an accurately titrated substance suspended, we shall say, in a vehicle of serum. So far as we are able to judge experimentally, the vehicle itself might be indifferent. In other cases in which the passive transference of immune serum is followed by undoubted success, as, for example, in anthrax, it has so far been impossible to determine precisely what particular principle in the serum so injected is responsible for the success. In other infections again, such as the coccal septicæmias, the success achieved has been but partial and fortuitous. Either the systems of titration on an *in vitro* basis have been unsatisfactory or, when biological titration has been partially possible, the existing great variety of coccal types both in man and animals and their contrary affinities for various animal species will doubtless for long militate against the elaboration of any rational and stereotyped scheme of serotherapy in these infections. We may learn, however, from our difficulties. We can see that Nature specifically unaided can successfully circumscribe the sphere of operation of a coccal or even an anthrax infection while she may fail to control a general invasion. We note also that Nature not infrequently appears to derive much assistance in the control of infection from the inoculation, for example, of a normal serum or from the inoculation of some type of colloid fluid circumspectly administered. Possibly the not infrequently observed phenomenon of the incompatibility of double infections may be placed in the same category of facts. In any case there would appear to be abundant justification at the present stage of immunological research for the closest study of the normal defence mechanisms.

THE MECHANISMS OF DEFENCE.

It is a strange circumstance that those curious instances of normal resistance which are referred to in all the text-books should rest on such an insecure basis of fact from what one might call the quantitative point of view. They, and the alleged explanatory mechanisms, appeared to fascinate the earlier workers intensely, but it does not appear that the experimental work devoted to their solution can now be regarded as authoritative in the light of present knowledge. It would seem that as each new mechanism of defence was discovered it was immediately tested and generally found to explain the observed resistance to the satisfaction of the discoverer. In what follows I shall illustrate what has happened in the case of anthrax and draw certain inferences as to future lines of progress. Put succinctly, the problem is simply this: Is the mechanism of a certain case of natural resistance capable of full and satisfactory expression in terms of test-tube analysis? Or must other mechanisms than those with which we are familiar be called in to explain the phenomenon?

The mechanisms are not many, and it would appear advisable to summarise them briefly before discussing their application to the problem in question. What contributions to the mechanism of defence were made by the great masters of general pathology and cytology

[1] From the presidential address delivered before the Section of Pathology of the Royal Society of Medicine on October 17.

of the past half-century? I need not discuss the various doctrines and conceptions of inflammation that formed the basis of pathological teaching of possibly most of us, but it is very obvious from even cursory analysis of the works of the great masters that the phenomena of inflammation gradually but surely came to be regarded in the light of natural defence mechanisms. That this was so is abundantly evident at the commencement of the present century, and in illustration I might cite the inaugural address of Marchand, a valued teacher of my own, on assuming the chair of Cohnheim at Leipzig in 1900. The title of his address was "Die natürlichen Schutzmittel des Organismus," and it was an attempt to summarise in the sense of defence mechanisms the various changes produced in the course of the inflammatory process. These changes he regarded as essentially defence mechanisms depending on the reactivity of the local tissues.

On the whole I receive the impression from reading the works of these masters that their methods of work were too local and circumscribed to render the results capable of general applicability to the phenomena of bacterial invasion. They had little conception then of the vast potentialities for defence residing not only in the fluids circulating in the inflamed part but also in the emigrated leucocytes and possibly also in the fixed tissue cells. Since those days the immunologist has had his innings, but I am of opinion that again we shall return to the consideration on ampler lines of local condition and function in the widest sense if we are to understand thoroughly the rationale of natural immunity. Already one sees a tendency towards the combined histological and serological attack on these problems.

I pass to Metchnikoff, whose attempt to extend the sphere of phagocytic action from the physiological to the pathological field, and to read into it the idea of a protective mechanism with an application to all higher animals possessing circulating amœboid elements, constituted the first large-scale conception calculated to raise the lore of inflammation from one of purely local to one of the most general application. It was, in fact, the commencement of immunity as a general science. To him the leucocyte came to be endowed with particular qualities and properties according to the reactivity of the host. It was, moreover, the source *par excellence* of any and all bactericidal substances that might be present in cell-free fluids of the body. The constant polemics into which his rigid adherence to the conception of the all-sufficiency of the phagocyte led him are now matters of history, but it has to be remembered that these very polemics with the rising school of humoralists led by Nuttall, Buchner, and a host of others, gave the stimulus to uncounted researches on the properties and sources of growth-inhibitory and bactericidal bodies in tissues and fluids. Metchnikoff sought to retrieve the position of the phagocyte by many ingeniously contrived experiments, but it was obvious that opinion was definitely ranged alongside the newer humoral ideas, while the ultimate source of the alexin and the intermediary body or *substance sensibilisatrice*, the co-operative action of which with a thermolabile alexin was later demonstrated, were left more or less open questions. The final demonstration by Denys and Leclef, Mennes, and others, showing the dependence of phagocytic action in immune serum on the presence of a *substance sensibilisatrice*, and the extension of the principle to normal serum by Wright and Douglas, constituted a reasonable enough compromise between the opposing views. We know, however, that absolutely independent phagocytic action cannot be excluded as a defence factor, especially when organisms of low virulence are in question, and researches on spontaneous phagocytosis have demonstrated that in a given collection of leucocytes exposed to organisms some individuals undoubtedly appear to possess much higher phagocytic powers than others. We have not reached the end of this particular problem.

After the phagocyte came the alexin of the cell-free fluids. The complex nature of the normal alexin and its presence both in plasma and in cell-free serum are now fairly generally accepted facts. It should be noted, however, that the complex nature of the normal alexin is much more difficult to demonstrate than that of the so-called bacteriolysin in immune serum, and, as we shall see, there is now evidence that certain normal sera possess considerable bactericidal and growth-inhibitory effects which are not destroyed by the usual inactivation temperatures. In fact, the test-organism in all these matters is of prime importance. Here it is sufficient to note that the normal alexin can kill or dissolve certain organisms while others are unaffected or at most suffer growth inhibition.

I pass to the leukins or the bactericidal substances present in extracts of leucocytes. The study of these arose largely out of the views expressed by Buchner and Metchnikoff that the source of the alexin might possibly be found in such. The chief work on this defence mechanism, which has not attracted perhaps the attention it deserves, has been that of Hahn, Schattenfroh, Petterson, Kling, Manwaring, Schneider, and Petrie. I would note simply that these extracts do not lose their power of killing certain test organisms after heating, say, at 60° F. They can resist very much higher temperatures, even up to 80° F. The constitution of these leukins or endolysins is still uncertain. Some have attempted to show that they possess complementing powers in the presence of inactivated sera, but others have entirely failed to confirm such action. Petterson would say that these extracts contain both an alcohol-soluble and an alcohol-insoluble fraction, and that the one can inhibit the action of the other. These effects, however, are almost certainly to be reckoned in the category of inhibition phenomena explicable on colloidal principles. The chief interest of the leukins lies in the effects they produce on different groups of organisms, and in the similarity of such effects to those produced by very analogous extracts prepared from tissues, which were demonstrated twenty years ago by Conradi, Korschun and Morgenroth, Tarassewitsch, and others. These leukins have, as a rule, been tested against organisms of the typhoid-coli group and organisms of the subtilis group, to which anthrax belongs.

Curious differences have been shown by extracts of leucocytes of various animal species in their action on bacterial types. Thus guinea-pig leucocytic extracts are said to possess little or no bactericidal action on *B. typhosus*, while those from the rabbit are distinctly potent. Petrie, however, using extracts prepared from leucocytes triturated at a temperature of liquid air, failed to demonstrate bactericidal bodies for *B. typhosus* in rabbit leucocytes. The leucocytic extracts of the hen have, according to Schneider, no action on *B. typhosus*, but a very considerable action on *B. anthracis*. On the other hand, the serum of the hen can kill *B. typhosus*, but has little action on *B. anthracis*, so that it would seem that absence of bactericidal property in the extract of a cell might be compensated by its presence in the surrounding fluid, and *vice versa*. The study of bactericidal bodies in tissue extracts and body secretions is again being actively pursued in connexion with bacteriophage problems. In the so-called bacteriophage, from whatever source it may be obtained, there is exhibited the same thermostability and *the same limitation of action to certain bacterial groups*. Rapidity of action of these leucocytic extracts on organisms of the subtilis group and slowness of action on organisms like *B. typhosus*, with subsequent over-growth of presumably resistant organisms, are features which recall those noted in investigations connected with the bacteriophage and with the bactericidal bodies present in egg-white as demonstrated by Rettger and Fleming.

I may close this subject by noting the existence of the thermostable bactericidal body in rat serum. This body has been carefully tested by Pirenne against organisms of the subtilis group, and also organisms like *B. coli* and *B. pyocyaneus*. Plating experiments have shown that organisms like *B. mycoides*, *B. megatherium*, *B. subtilis* are rapidly killed off, while *B. proteus*, *B. coli*, and *B. pyocyaneus* multiply freely. The cholera vibrio is also killed off, but this action was found to be due to the ordinary thermolabile alexin in the rat serum and it disappeared after inactivation of the serum.

There remain only the proteolytic bodies contained in leucocytes, which have been studied by many workers chiefly in connexion with the so-called antitryptic action of serum. We know little or nothing of their action on bacteria, and indeed it would be difficult to separate any such action exhibited from that due to the more generally studied endolysins. I may just mention the alleged existence of bactericidal bodies in platelets, a subject introduced by Gruber and Futaki in 1907, and but little studied since. These authors came to the conclusion that the bactericidal action on anthrax of normal rabbit serum (a highly susceptible animal) depended on substances derived from the platelets. Barreau, who continued this work, found that the serum of the dog (a highly resistant animal to anthrax) had no action on anthrax nor had its platelets. He concluded, however, that the platelet bactericidal bodies or plakins probably did not play much part in natural resistance, as the rat, for example, a resistant animal, was rich in plakins, while the rabbit, a susceptible animal, was equally so. It is possible that the recent work on the purely mechanical function of blood platelets in removing suspended organisms by virtue of their adhesive properties may throw a different light on these alleged bactericidal substances in platelets.

Animal Experiments.

The application of these defence mechanisms to the elucidation of natural resistance to anthrax can now be very shortly considered. The resistant animals chiefly studied have been the frog, the fowl (especially the hen and pigeon), the rat, and the dog, but we have no accurate data of a quantitative kind as to the extent of this resistance in most cases. There is no doubt that the frog presents an extraordinary resistance to anthrax infection—a resistance which in the early days was attributed to its low body temperature. Attempts were made to infect frogs kept at 37° C., and in these circumstances the animals readily succumbed. Metchnikoff attributed the deaths in these cases to diminished phagocytic action, whereas in the frog whose temperature was not interfered with, exuberant phagocytosis at the seat of inoculation afforded sufficient explanation of the immunity. The humoralists, however, maintained that the immunity was due to the bactericidal properties of the local lymph (Nuttall, Baumgarten, Petruschky, etc.). Metchnikoff countered this by showing that *B. anthracis* could grow readily in frog plasma. Galli-Valerio favoured the combined action of phagocytosis and bactericidal property of lymph as the most likely explanation. The matter remains quite obscure, and a more recent worker, Ditthorn, simply states that anthrax rods inoculated in any way into frogs show degenerative changes in a few days and lose their contours. The test organisms may, of course, play a decisive rôle in view of the fact that Dieudonné, for example, cultivated a race of anthrax growing abundantly at 12° C., and with it succeeded in killing frogs readily. These experiments require confirmation.

With regard to fowls, the hen and pigeon, and particularly the former, are known to possess high resistance, and in the classical experiments of Pasteur and Joubert, in 1878, the immunity was attributed to the high body temperature of the fowl. By immersing the fowl in cold water infection took place. The death in such circumstances has been attributed by later workers to a general lowering of resistance, and not to an inability on the part of *B. anthracis* to grow at the high temperature of the fowl. Metchnikoff maintained that phagocytosis in the normal hen was rapid and complete, and in the cooled hen very poor. Later, Thiltges stated that phagocytosis was not in evidence, and that the immunity was due to the bactericidal action of the plasma, a property which Gengou denied. Thiltges agreed, however, with Metchnikoff in the matter of the pigeon. Bail and Petterson and Schneider ascribe the resistance to the action of the hen leukins, which act very powerfully on *B. anthracis*, while the serum has relatively little action. Donati in a more recent communication ascribes the immunity of the fowl simply to a local invasion of leucocytes, which hinder capsule formation, and by virtue of bactericidal substances secreted by them, and not by phagocytosis, secure the removal of the invaders.

It is notorious that the adult dog can tolerate without inconvenience the inoculation of large quantities of bacilli, and, as one might expect, this immunity has been attributed by Metchnikoff to phagocytosis at the site of inoculation. Hektoen later showed that in the presence of dog serum dog leucocytes readily took up *B. anthracis*. It would appear that the serum of the dog has but little or no anthracidal action as compared, for example, with that of the rabbit, which is, on the contrary, a fairly highly susceptible animal. While without action on *B. anthracis*, dog serum, according to Petrie, has a powerful action on *B. typhosus*. Hektoen attributes some importance also to the leukins of the dog. Petrie, however, found none.

The rat presents a more interesting problem, though it has to be remembered that there is no absolute immunity in this species. Behring, in 1888, showed that rat serum was anthracidal, while Metchnikoff found that the main defence was the phagocytic response. The thermostability of the bactericidal body in rat serum, as shown by Pirenne and Horton, is a most interesting feature. It acts equally well at 18° C. as at 0° C., and remains active for fairly long periods in the cold.

SUMMARY.

To summarise, it must be confessed that the curiously contradictory and yet perhaps genuinely reasonable explanatory theses give us very little that is solid to grasp. No one example of normal immunity has yet been investigated as a complete problem. Partial mechanisms only have been studied. It might be concluded from the above that dogs are immune because dogs are dogs, and so for rats, fowls, and frogs, but that would not be quite the impression I should like to make. If a certain animal is immune to a particular experimental infection, such as anthrax, one ought to be able to explain fully what local phenomena have occurred to prevent a general invasion by the organism. To do so effectively must involve the testing of each possible mechanism separately and in conjunction, and it must involve a return to the cytological study of the changes which the invading organism undergoes *in situ*. The problem must be attacked not only by methods which derive their authority from long experience with the bactericidal properties of cells and fluids, but also by methods which reflect the trend of present-day studies on general metabolism both of parasite and host. With regard to the former much has been made of the capsule, but the data on the point are contradictory. In every set of experiments strict attention must be paid to the maintenance of virulence. It may, indeed, be found that by experimental selection a test organism which has once proved virulent for one individual of a resistant species may prove equally so for all individuals of the species. Strains of *B. anthracis* have been thus selected which are alleged to have killed fowls, rats, and frogs, but the experiments lack confirmation.

Another important aspect of the subject which has recently been brought to the forefront by Besredka relates to the site of inoculation of the test organism. In the course of his researches on the production of immunity by vaccinating that portion only of the body which is most susceptible, Besredka has turned his attention to anthrax infection in the guinea-pig, an animal notoriously difficult to protect by any method of vaccination. He shows experimentally what, by the way, had been amply demonstrated twenty years ago by Noetzel, that animals like the rabbit and guinea-pig can tolerate easily doses of virulent anthrax if introduced directly into the circulation or into the peritoneal cavity without contaminating the cutaneous tissues. This can be avoided by a special and careful technique. According to Besredka the skin of the guinea-pig is the only susceptible portion of the guinea-pig's anatomy, and if it had no skin it would be a highly refractory animal instead of being, as it is, one of the most susceptible. He further demonstrated the possibility of securing solid immunity to anthrax, by whatever route inoculated, by vaccination of the skin with the attenuated Pasteurian vaccines. I do not wholly accept much of the evidence adduced so far in support of the conception of partial or local immunities or susceptibilities, but I believe the matter is worth the fullest investigation. In any case it is obvious that future work on natural resistance must take count of the possibility of very diverse immunities or susceptibilities apparently combined in one immune whole.

I have dealt with species resistance solely, but it has to be remembered that there are racial variations of resistance within the species. For this reason the study of the mechanism of normal immunity will doubtless demand the services of the geneticist, who will be responsible for securing pedigreed stock for experimental purposes. This is no fanciful suggestion. In connexion with these most promising developments in experimental epidemiology which are being carried out in this country and in America the services of the geneticist must be invaluable. The dietetic factor, too, may prove of supreme importance in experiments on natural resistance, and there is already a body of evidence pointing in this direction. It is possible also that we may learn from comparative observations on the rationale of natural immunity in plants to fungal infections. In a recent address by Blackman some of these mechanisms reveal extraordinarily interesting relationships between the attacking fungus and the cells of the immune host.

Helium in the United States.

By Dr. RICHARD B. MOORE, Chief Chemist, U.S. Bureau of Mines.

ONE of the projects started in the United States during the war and since continued, is the extraction of helium from natural gas for use in balloons and dirigibles. In 1907, Cady and McFarland published a report on the presence of helium in a number of natural gases, mainly from Kansas, U.S.A. Some of the samples tested ran as high as 1½ per cent. helium by volume, although the majority of them were considerably below this figure.

Early in 1915 the present writer received a letter from Sir William Ramsay, written under date of February 28. In that letter it was stated that the British Government was interested in new sources of helium other than the atmosphere, in the hope that a sufficient amount could be obtained for use in dirigibles. It was only during my recent visit to England last summer that I learned of Sir Richard Threlfall's intimate connexion with the origin of this demand for a supply of helium by the British Government.

American Government officials heard no more of the project until after the United States entered the war. A few days after that event, I suggested at the meeting of the American Chemical Society in Kansas City that

FIG. 1.—Helium production plant, Fort Worth, Texas, operating at the present time.

helium could be, and should be, extracted from natural gas, and the project was afterwards taken to the U.S. Army by Col. G. A. Burrell and myself. Col. Chas. De F. Chandler in charge of the lighter-than-air branch of the Air Service, was immediately interested. The Army and Navy jointly asked the Bureau of Mines to undertake

FIG. 2.—Experimental plant No. 1 (Linde system) built and used during the war. Inside a compressor building.

the experimental development of the project, and three plants were built in Texas in connexion with the supply of natural gas derived from the Petrolia, Texas field, used in the cities of Fort Worth and Dallas. Two of these plants were situated at Fort Worth (Fig. 1), and one at Petrolia. The plants at Fort Worth used the Linde and Claude systems respectively. The plant at Petrolia was equipped with the new Jefferies-Norton system of refrigeration.

During the preliminary stages of the work, Col. Burrell acted for the Bureau of Mines, but shortly afterwards I was assigned by the director of the Bureau to take general charge of the three plants. Others who were connected with the work in the early stages were Dr. Van H. Manning, director of the Bureau of Mines, Dr. F. G. Cottrell, assistant director, and Commanders A. K. Atkins and H. T. Dyer, and Mr. G.

O. Carter, of the U.S. Navy. It was not known at that time that the British Government, through Prof. J. C. McLennan, of the University of Toronto, was carrying out experimental work with the same object in view in Canada.

The U.S. Government had the active co-operation of the Linde Company, the Air Reduction Company, and the Jefferies-Norton Company, and the engineers of the first two companies actually operated their plants. Whatever success was achieved in the commercial production of helium was to a very considerable extent due to the ability of the engineers of the companies mentioned.

Plant No. 1 (Fig. 2), using the Linde process, commenced to work on March 6, 1918, and made its first helium on April 8, 1918, when some gas analysing 27 per cent. helium was obtained. This purity was increased after a few months until in the early part of July a grade of above 70 per cent. was obtained, and in September the plant was operating very consistently, producing an average of from 4000 to 6000 cubic feet of 70 per cent. helium during each operating day. It was necessary to re-process the gas in order to raise this purity to more than 90 per cent.

Plant No. 2, using the Claude system, began to operate on May 1, 1918, and very quickly obtained some helium. On May 13 some gas of a grade between 60 and 70 per cent. helium was produced. The operations of Plant 2, however, were not as a whole so successful as those of Plant 1.

Plant No. 3, using the Jefferies-Norton process, started operations in the late fall of 1918. It was hoped that this plant would show some economies which could not be hoped for from the other two more or less standardised processes. Whereas helium was produced at various times by Plant No. 3, it was never able to produce helium steadily or consistently, and was finally permanently shut down during July 1921.

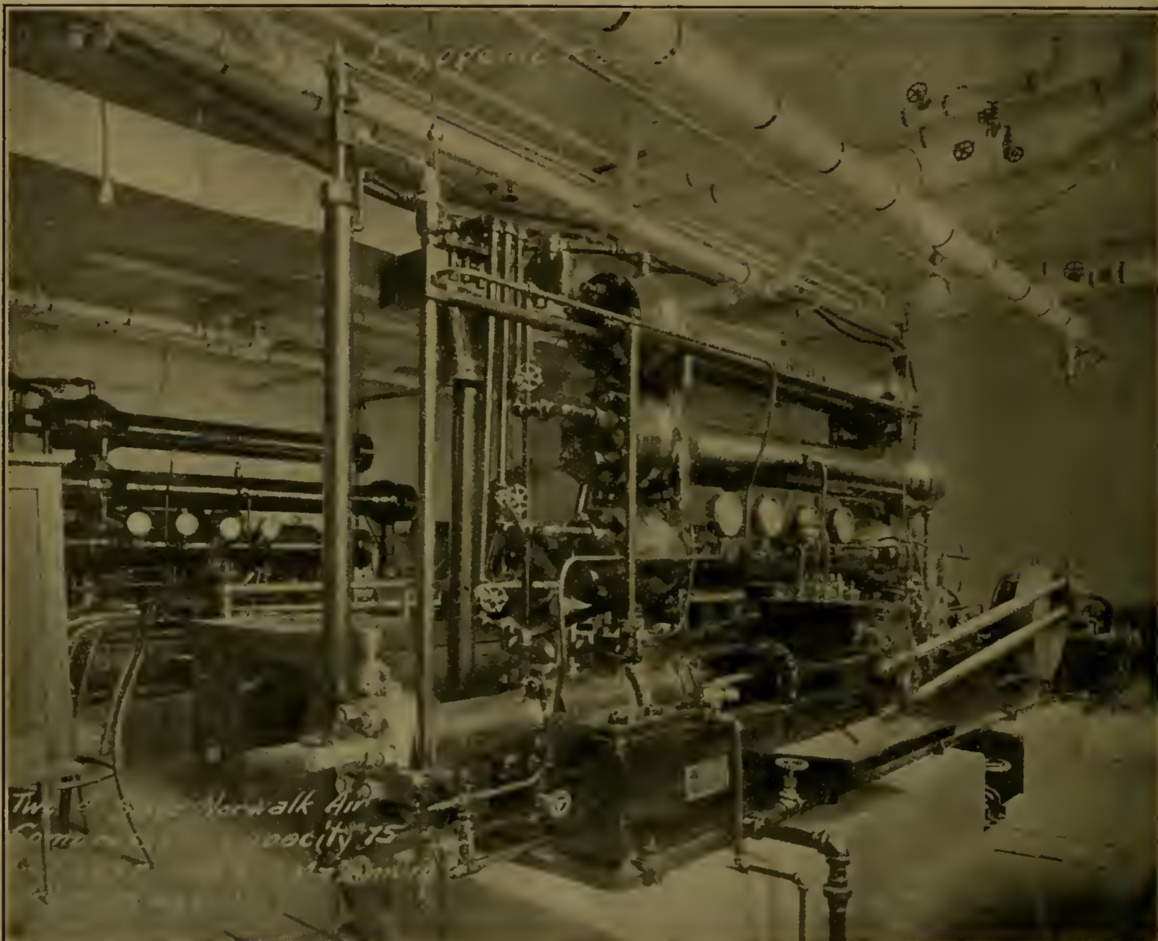

FIG. 3.—Compressors for experimental work in Cryogenic Laboratory, U.S. Bureau of Mines.

The Linde plant showed the most rapid progress, and it was decided in the fall of 1918 to build a large production plant using the Linde process. This plant was completed in the spring of 1920, and operated for a few months during that year. Most of the time, however, was spent on testing out the equipment. About two million cubic feet of helium averaging 94 to 95 per cent. was produced, and this, with the helium obtained during the experimental work with the smaller plants, gave a total production up to this year of 2,300,000 cubic feet. Congress has furnished a fairly satisfactory sum for operations during the present fiscal year, July 1, 1922 to June 30, 1923, and the plant is now producing about 15,000 cubic feet of 93 to 95 per cent. helium per day.

Some small changes have to be made, and after these have been installed, it is expected that this production will be considerably increased. When all the units are operating efficiently, the plant will probably have a capacity of from 35,000 to 40,000 cubic feet per day.

An important part of the work has been the investigation of the natural gas supplies of the United States for their helium content. This work was originally started during the war, and Mr. G. S. Rogers, of the U.S. Geological Survey, was transferred to the Bureau of Mines to carry on the work. A preliminary report was published by the Survey in 1921 (U.S. Geol. Sur. Professional Paper 121, by G. Sherburne Rogers).

Since 1919 the present writer has supervised the field work along with other helium activities; and the Bureau maintained a full force and laboratory for this particular purpose for nearly two years. Every gas field in the United States has been sampled, and at the present time undoubtedly more than five hundred million cubic feet of helium is going to waste annually in connexion with the natural gas of the United States. A considerable proportion of this is widely scattered in gas-wells that have a small helium content, of only 0·1-0·2 per cent., but a considerable amount of it is concentrated in large fields which have an average of more than 0·5 per cent. helium in the gas, and some of the wells go above 1·0 per cent. and even 1½ per cent. In general, the helium belt extends from Texas through Oklahoma, south-eastern Kansas, southern Illinois, and from there through Ohio into Pennsylvania and New York. There is also helium-bearing gas in Indiana, Kentucky, and West Virginia. The belt seems to go from south-west to north-east, generally speaking, the richest gas being in Texas, Oklahoma, and Kansas.

Though helium is being produced successfully commercially, we are not satisfied with the present development or costs. A considerable amount of research work is being carried out, therefore, with the main object of getting greater efficiency and reduction in cost.

The low-temperature laboratory (Fig. 3) is attached to the Bureau of Mines in Washington, with a force of about fifteen chemists, physicists, engineers, and mechanics. A thoroughly adequate equipment is available. A good deal of fundamental research work is being carried on and applied to the commercial production of helium. A consulting board of engineers consists of Mr. M. H. Roberts, Prof. W. L. De Baufre, and Dr. R. C. Tolman. This board is giving efficient and valuable help on plant design. It is assisted by Mr. J. W. Davis of the Bureau of Mines, and other members of the technical force. Mr. C. W. Seibel, Dr. A. G. Loomis, Dr. Leo Finkelstein, and Mr. W. V. Cullison have been with the work for a considerable time, and are giving valuable service.

Two repurification plants are being constructed by the Bureau of Mines for the U.S. Army. The object of these plants is to repurify the helium after it has been used in a balloon or dirigible. One of these plants is situated at Langley (Aviation) Field, Va., and uses the ordinary combination of low temperature and high pressure in order to step up the purity of the gas. Dr. H. N. Davis has acted in a consulting capacity for this plant. The present writer felt from the early start of the project that the use of charcoal at low temperatures would be of value, and, therefore, a considerable amount of research work has been carried out, and has culminated in a repurification plant in two railroad cars. One of these cars is equipped with a self-contained power unit, and the other contains the necessary compressors, refrigeration outfit, and charcoal purifiers. By means of charcoal, a purity of practically 100 per cent. can be obtained. Both these plants will be ready for operation within a very short time.

At the present time the Helium Board which handles the whole project consists of Col. I. F. Fravel, Commander S. M. Kraus, and myself. Others beside those already mentioned in this statement who have been intimately connected with the work are Major O. Westover, Major P. E. Van Nostrand, and Lieut. R. S. Olmsted, of the U.S. Army.

Current Topics and Events.

The following presidents and recorders of the various sections of the British Association have been appointed for the Liverpool meeting to be held in September next under the presidency of Sir Ernest Rutherford :—*Section A* (*Mathematical and Physical Science*) : Prof. J. C. McLennan ; Prof. A. O. Rankine, Imperial College of Science and Technology, S.W.7. *Section B* (*Chemistry*) : Prof. F. G. Donnan ; Prof. C. H. Desch, The University, Sheffield. *Section C* (*Geology*) : Dr. Gertrude Elles ; Dr. A. R. Dwerryhouse, Toots, Darell Road, Caversham, Reading. *Section D* (*Zoology*) : Prof. J. H. Ashworth ; Prof. R. D. Laurie, University College, Aberystwyth. *Section E* (*Geography*) : Dr. Vaughan Cornish ; Dr. R. N. Rudmose Brown, The University, Sheffield. *Section F* (*Economics*) : Sir W. H. Beveridge ; Prof. H. M. Hallsworth, Armstrong College, Newcastle-on-Tyne. *Section G* (*Engineering*) : Sir H. Fowler ; Prof. G. W. O. Howe, The University, Glasgow. *Section H* (*Anthropology*) : Mr. P. E. Newberry ; Mr. E. N. Fallaize, Vinchelez, Chase Court Gardens, Enfield, Middlesex. *Section I* (*Physiology*) : Prof. G. H. F. Nuttall ; Prof. C. Lovatt Evans, Physiological Laboratory, St. Bartholomew's Medical College, E.C.1. *Section J* (*Psychology*) : Mr. C. Burt ; Recorder not yet appointed. *Section K* (*Botany*) : Mr. A. G. Tansley ; Mr. F. T. Brooks, 31 Tenison Avenue, Cambridge. *Section L* (*Educational Science*): Prof. T. P. Nunn ; Mr. D. Berridge, The College, Malvern. *Section M* (*Agriculture*) : Dr. C. Crowther ; Mr. C. G. T. Morison, School of Rural Economy, Oxford.

The Buys Ballot medal founded in 1888 in commemoration of the work of C. H. D. Buys Ballot, the famous meteorologist of the Netherlands, to be awarded by the Royal Academy of Science at Amsterdam first in 1893, and afterwards every tenth year, to the person who is judged to have made the most valuable contributions to the science of meteorology, is to be given this year to Sir Napier Shaw, professor of meteorology in the Royal College of Science, late director of the Meteorological Office, for contributions to all branches of the science, and specially for his work as president of the International Meteorological Committee. The previous awards were: 1893, Dr. Julius Hann, of Vienna; 1903, Dr. R. Assmann and Dr. A. Berson, of Berlin, jointly; 1913, Dr. H. Hergesell, of Strasbourg.

MR. E. A. REEVES, map curator of the Royal Geographical Society and director of the society's School of Surveying, has been awarded the Cullum Gold Medal for 1922 of the American Geographical Society. The inscription on the reverse side of the medal reads as follows:—" Edward A. Reeves, 1922. In honour of his substantial achievements in geographical surveying. By devising and improving instruments and methods he created new standards in the field of scientific exploration." Mr. Reeves has now been in charge of the Royal Geographical Society's courses of instruction in map construction and surveying for twenty years, and during that period almost every British explorer, as well as many from other countries, have had the advantage of his practical knowledge and precise methods. One of these pupils was Dr. Hamilton Rice, vice-president of the American Geographical Society, who worked through the course some years ago and obtained the diploma. This society is starting a survey school for travellers and explorers under Dr. Rice's direction, and the future instructor, Mr. Weld Arnold, late Austin teaching fellow in astronomy at Harvard University, is now passing through the Royal Geographical Society's course. The award to Mr. Reeves is no doubt in some measure a mark of recognition of his valuable services in connexion with these developments.

The annual council meeting of the National Union of Scientific Workers was held at the Caxton Hall, Westminster, on January 13. Dr. A. A. Griffith, who presided, gave an address on " The Support and Utilisation of Science," in which he stated that it was the general opinion of men of science that the support of science in Great Britain is quite inadequate considering the needs of the country. He regarded it as absurd that science, the greatest and most permanently valuable of all the learned professions, is also the worst paid, and outlined a general policy for adoption by the Union which aims at remedying this condition of affairs. Scientific workers themselves must be held largely to blame for their present unenviable position, and would only prove their value to the community when they undertook a greater share of responsibility in the control of the product of their labours. Unity among men of science is the first essential of success, he declared. Dame Helen Gwynne-Vaughan was unanimously elected president for the ensuing year, and the following were elected members of the executive committee: Profs. J. McLean Thompson and H. Levy; Drs. H. Jeffreys, G. Senter, J. H. Vincent; Messrs. W. L. Baillie, E. G. Bilham, F. T. Brooks, L. D. Goldsmith, R. McKinnon-Wood, S. W. Melsom, and H. V. Taylor.

AT a large gathering of Whitworth scholars and exhibitioners held at the Institution of Mechanical Engineers on Friday, January 12, the Whitworth Society came into being. The president of the Institution—Dr. Hele-Shaw, himself an old Whitworth scholar—welcomed those present, and took the chair. There had been great difficulty in getting into touch with Whitworth men, but more than three hundred had indicated their desire to support a society if formed, and about 120 were present at the meeting. The new society will enable old scholars, exhibitioners and the prizemen who will come into being under the new scheme of award to keep in touch with one another. It has no connexion with any existing institutions, although there is no doubt that these will welcome its advent. Dr. Hele-Shaw was elected president of the new society, and a provisional committee was appointed. It will assist greatly if any such who have not already received communications would send their names and addresses to the secretary, the Whitworth Society, Institution of Mechanical Engineers, Storey's Gate, London, S.W.1. It is proposed to have an annual social function on the anniversary of Sir Joseph Whitworth's birth—December 21—and the committee has been asked to organise if possible a similar function to take place within the next three months. An interesting feature of the meeting was the number of men, many occupying prominent positions in their professions, who bore testimony in speech and in letters to the value which Sir Joseph Whitworth's generosity had been to them in their educational training in engineering.

ACCORDING to the *Journal officiel de la République Française*, the " Croix de chevalier du Mérite Agricole " has recently been awarded by the French Ministry of Agriculture to 287 agriculturists, both men and women, whose families have dwelt on the same agricultural holding for more than one hundred years and who are themselves still carrying on the working of the land. Exceptional interest attaches to two cases on account of the long association of the families of the recipients with the property. M. André Dupont, of Lacoux (Ain), traces his descent back for eight hundred and twenty-two years on the same holding; he himself has devoted his life to practical agriculture, and for the last thirty-five years has done much to extend agricultural co-operation. M. Pierre Lascassies-Poublan, of Lucgarrier (Basses-Pyrénées), is also an excellent farmer and is president of various co-operative societies connected with agriculture. In this case the family has been uninterruptedly associated with the same land over a period of eight hundred and eighty-nine years.

THE Royal Scottish Society of Arts has awarded the following prizes for communications read or reported on during the session 1921–22: Keith prizes to Principal A. P. Laurie for his paper on " The 'Pier Method' of Building Brick Walls," and to Dr. Henry Briggs for his paper on " A New Mine Rescue Apparatus "; Makdougall-Brisbane medals to Andrew H. Baird for his paper on " The Universal Bosshead-Clamp," and to Dr. Dawson Turner and

D. M. R. Crombie for their paper on "An Investigation of the Ionised Atmosphere around Flames by means of an Electrified Pith Ball"; and a Hepburn medal to Basil A. Pilkington for his paper on "A Readily-Destructible Material suitable for the Conveyance of Confidential Communications."

In connexion with the work of the School of Meteorology of the Royal College of Science, Sir Napier Shaw, professor of meteorology at the College, will give a course of ten lectures on "Forecasting Weather," at the Meteorological Office, South Kensington, during the current term. The lectures are on Fridays at 3 P.M., beginning on Friday, January 19. Admission is free by ticket to be obtained from the Registrar of the Imperial College of Science, South Kensington, S.W.7.

Owing to the exceptional demand for tickets for his lecture on January 23, Prof. W. M. Flinders Petrie has consented to repeat the lecture on "Royal Burials in Egypt" on Saturday, February 3, at 2.30 P.M., at University College, London. The lecture, which will be illustrated by lantern slides, will have special reference to the recent excavations in Egypt. The proceeds will be devoted to the St. Christopher's Working Boys' Club, which is connected with the Union Society and Women's Union of the College. A leaflet containing full particulars as to the prices of the tickets can be obtained by sending a stamped addressed envelope to Dr. Walter Seton, University College, London (Gower Street, W.C.1.).

The council of the Geological Society has this year made the following awards:—Wollaston Medal, Mr. W. Whitaker; Murchison Medal, Dr. J. Joly; Lyell Medal, Mr. G. F. Dollfus; Bigsby Medal, Mr. E. B. Bailey; Wollaston Fund, Mr. H. H. Read; Murchison Fund, Mr. T. H. Withers; Lyell Fund, Dr. W. T. Gordon and Dr. W. N. Benson.

What is claimed to be the first deliberately organised radio-telephone conversation between Great Britain and the United States is recorded in the *Times* of January 16. In the early hours of the morning of January 15, Mr. H. B. Thayer, president of the American Telephone and Telegraph Company, succeeded in addressing a party of press representatives and others at the New Southgate (Middlesex) works of the Western Electric Company, Limited, from his office at 105 Broadway, New York. Communication was maintained for two hours. The demonstration was carried out by the American Telephone and Telegraph Company and the Radio Corporation of America, which had installed a transmitting apparatus for the purpose at Rocky Mount, Long Island. The transmitter was connected with New York by telephone wires. The power used is stated as "several hundred" kilowatts and the wave-length was approximately 5350 metres. At New Southgate a special receiving set with eight valves was employed, with an indoor frame aerial about six feet square. It is stated that most of the words spoken by Mr. Thayer and others who followed him were heard both by means of head telephones and also by a "loud-speaker" so clearly that it was possible to recognise one of the speakers by his intonation. The success of this experiment in transmitting the spoken word from the New to the Old World is a noteworthy step in the progress of practical radio-telephony.

The annual general meeting of the Institute of Metals will be held on Wednesday and Thursday, March 7 and 8, at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, commencing at 10.30 A.M. each day. The council is arranging a special ballot on February 22 for the election of members in time for this meeting, and candidates who are elected will enjoy the privileges of membership for the extended period ending June 30, 1924. With the view of developing the membership of the Institute Overseas, the council has recently appointed a British Empire Committee on which the Overseas Dominions are represented by distinguished metallurgists in London possessing an intimate knowledge of Overseas conditions. A local section of the Institute has just been formed in Swansea as a sequel to the autumn meeting of the Institute held there in September last. Thus the Institute now has sections in Birmingham, Newcastle-on-Tyne, London, Sheffield, Glasgow, and Swansea.

A special exhibit of epiphytic ferns belonging to the genus Platycerium and some species of the genus Polypodium has been arranged in the Tropical Fern House at the Royal Botanic Gardens, Kew. These ferns live mainly in the air attached to tree trunks, and they have developed either specially modified bases to their leaves—as, for example, *Polypodium Heracleum*, *P. conjugatum*, and *P. Meyenianum*—or special "shield" or "collecting" leaves, as in *P. quercifolium*, *P. Vidgeni*, and *P. rigidulum* var. *Whitei*, which serve to collect the humus and detritus washed down the trunks. In the case of the Stag's Horn Ferns (Platycerium) the collecting leaves are specialised organs which wrap round the tree trunks, and the roots grow out into the pockets so formed. The shield-like base of the frond of *Polypodium Heracleum* remains green, as does also the whole shield-leaf in *Platycerium grande* and *P. Veitchii*, while in *Polypodium quercifolium* etc., *Platycerium alcicorne*, *P. æthiopicum*, and *P. Willinckii*, etc., the shield-leaf turns brown and functions only as a collecting leaf, the frond which remains green and bears the sporangia or reproductive bodies being a separate frond. The Bird's Nest Fern, *Asplenium Nidus*, and other ferns which tend to make pockets with their leaves may be compared with these Polypodiums and Platyceriums, and are also exhibited near them.

Useful work is being done by the various trade and technical committees of the British Empire Exhibition to be held at Wembley in 1924. It is to these committees that the executive council and the management committee have delegated the task of organising representative exhibits of the particular trades with which they are concerned. The larger industries are being organised entirely by their own trade associations, including the British Engineers' Association for mechanical engineering exhibits, the British Electrical and Allied Manufacturers' Association for all electrical exhibits, and the Association of British Chemical Manufacturers; but in the case of many other trades about fifty representative committees have been set up to work in conjunction with the exhibition officials, and they are now holding regular monthly or fortnightly meetings, with the object of inviting exhibitors, individually or in groups, securing the requisite amount of space, and arranging and classifying the exhibits. The committees are getting into communication with all traders in the different trades. Some of the smaller traders, it is thought, may desire to economise by exhibiting in groups. Provision for this will therefore be arranged. Sir Lawrence Weaver, director of the United Kingdom Exhibits Section, is attending the meetings of these committees, in order to explain the nature of the work, and to see that the committees are enlarged, where necessary, to ensure their representative character. He has explained also that the executive committee, desiring to evolve unified schemes of decoration for each section, has obtained the services of a panel of eminent architects who will advise committees in regard to decorative schemes.

THE annual meeting of the Circle of Scientific, Technical, and Trade Journalists was held in the Hall of the Institute of Journalists on January 9, when Sir Richard Gregory was elected chairman in succession to Mr. L. Gaster (32 Victoria Street, London, S.W.1), who has been chairman for the past eight years and has now consented to serve as secretary. In opening a discussion on "Reviews and Reviewers," Sir Richard Gregory referred to the distinctions between the points of view of publisher, author, and editor. The first concern of an editor is, however, the interests of his readers. So many books are received for review by leading journals that it is impossible to find space to notice them all, and a selection has, therefore, to be made. Books may be selected for special notice on account of (1) wide interest of subject, (2) eminence of author, (3) outstanding importance. The most readable review, if written with expert knowledge of the subject, is editorially the most acceptable and probably best directs attention to the book noticed. A mere statement of contents is not a review, though a descriptive synopsis may serve a useful purpose. Readers are not interested in long lists of errors, and it is preferable to send such lists to publishers or authors instead of printing them. Books not selected for special reviews may be dealt with in short notices, but, on account of limitations of space, many can be mentioned only in lists of books received. It was the general opinion of the editors of different types of technical journals who took part in the discussion that while an unsigned review might be subjected to a certain amount of editing, no essential change should be made in a signed review. Custom has sanctioned the principle that a book noticed by a reviewer becomes his property, and the view was expressed that, provided a reasonable period had elapsed since the date of publication, books merely announced might be sold or disposed of in any way.

Our Astronomical Column.

THE DRAYSON PARADOX.—A pamphlet by Mr. A. H. Barley on "The Drayson Problem" shows that this curious paradox has still a considerable vogue. It had its origin solely in the somewhat loose language of certain text-books which described the motion of the pole of the equator as circular, the pole of the ecliptic being in the centre. This description would be correct if only the solar and lunar precessions were concerned, but planetary perturbations cause the plane of the ecliptic (and hence its pole) to shift, thus causing a variation in the radius of the circle. Drayson, without carefully studying the evidence for the shifting ecliptic, asserted that it was really fixed among the stars, and that the centre of the north pole's motion was 6° away from the ecliptic pole, thus bringing about a very large change in the obliquity, which he supposed to be near its minimum at present. It would reach 35° at its maximum, when Drayson considered an Ice-age would occur. Drayson's supporters slur over the fact that all the planetary orbit planes are changing, owing to mutual perturbations, theory and observation being in good agreement. Further, they claim to account for stellar proper motions by their revised precessions, omitting apparently to note that motions due to a mere change in the earth's axis would affect all the stars in the same region of space alike, whereas the actual motions differ from star to star, as can readily be verified from stellar photographs. If the Draysonians would study the full collection of modern observations of sun, planets, and stars, instead of wresting a few isolated observations to suit their preconceived views, they would soon be convinced that their hypothesis is not consistent with the facts, but that the ecliptic is actually shifting through an angle of some 47″ per century.

PARALLAXES OF FIFTY STARS.—The Sproul Observatory has just issued No. 6 of its publications, a continuation of numbers 4 and 5, which contains a third list of trigonometrical parallaxes of 50 stars. The observational work has been spread over the years 1915–1921 and the results were obtained through the efforts of several persons named in the volume. The list includes stars of various types of spectra and magnitudes, the latter ranging from 2·81 to 10·5. This list is very opportune, as the values will assist in the researches now being carried out in the determination of parallaxes by the spectroscopic method.

VARIABLE STAR MAXIMA AND MINIMA FOR 1923.—Variable star observers will find the Harvard College Observatory's Circular No. 241 very useful. Dr. Leon Campbell publishes in it the predicted dates of maxima and minima for variable stars of long period. The dates for 366 variables are inserted in the table. The information is given in the following form: first, six figures which denote the Right Ascension and Declination of the star; next, the name of the star according to the new nomenclature instituted by the International Astronomical Union; and, lastly, the dates of the maxima and minima showing the months and days of the month. Thus, for example, o Ceti or "Mira" with R.A. $2^h\ 14^m$ and Dec. $-3°$ reaches a maximum on April 2 and a minimum on October 23.

Research Items.

KENT'S CAVERN ANTHROPOLOGY AND THE ICE AGE.—In the Journal of the Torquay Natural History Society (vol. iii. No. 2, 1922), Mr. H. J. Lowe gives a full account of the questions connected with the exploration of Kent's Cavern. The first exploration was made by MacEnnery in 1825, but the success attained was due to the labours of W. Pengelly, who spent sixteen years in excavating and recording his discoveries. Probably the greatest service Pengelly did for anthropology was when, with a keen appreciation of the importance of the results already attained, he secured the right to investigate a newly found cavern at Brixham, across the bay from Torquay. The writer, comparing the results of excavation at Kent's Cavern, Brixham, and Tor Bryan caves, with those of a Belgian cavern in about the same latitude, as noted by Schmerling, advances the theory that their floors mark periods of climatic severity that destroyed life so far south, at least, as the latitude in which they occur; and inferentially that they may be regarded as indications of cosmical changes that need to be discovered in order to explain the phenomenal coincidences.

SHRUNK HUMAN HEADS.—The *Lancet* (November 11, 1922) publishes an address, entitled "Spolia Nemoralia: Shrunk Heads, Ear-plugs, and Labrets," delivered by Sir John Bland-Sutton before the Royal Society of Medicine. The art of producing these shrunk heads is found among Indians dwelling in the dense forests bordering the section of the Amazon known as Marañon. The specimens exhibited were collected by the lecturer on a visit to the Amazon, and further information has been acquired by Mr. G. M. Dyott in a recent adventurous journey. As a rule a corpse is flung into the river, but when a man is killed in combat his body is mummified, wrapped in bark, and placed on a stand in the centre of the hut as an object of veneration. After the skull is removed the flesh of the head is stuffed with hot pebbles or hot sand and carefully dried in the sun. When this rude taxidermic process is complete, the flesh shrinks to the size of an orange, preserving the features. It is clear that Amazonian Indians, as well as the natives of East Africa, like surgeons in civilised countries, are familiar with the elastic properties of the human skin.

DISTRIBUTION OF THE BOTULISM ORGANISM.—A good deal of interest was aroused last year over the outbreak of food poisoning at Loch Maree in Scotland, where a number of fatalities followed the eating of some potted meat in which, for the first time in this country, the *Bacillus botulinus* was identified as the causative agent. The last number of the *Journal of Infectious Diseases* (vol. xxxi. No. 2) contains a series of papers from the University of California by Prof. K. F. Meyer and his colleagues on the distribution of this organism. In 624 samples of soil, vegetables, fruit, feeding stuffs, etc., collected in California, the bacillus was found in about 30 per cent., and, contrary to the common assumption, more abundantly in virgin mountain and forest soils than in cultivated places. By serological reactions two types, A and B, may be distinguished, and it is the former that is particularly associated with wild places. Extending their studies more widely, they have found it in earth all over the United States, more abundantly and more generally of type A in the west than the east, in Canada, Belgium, Denmark, Holland, England, Switzerland, China, and Hawaii. The bacillus seems indeed to be a common soil anaerobe; like other bacteria, it has a world-wide distribution, either because it is easily transported or because it is ancient. It is not, like the tetanus bacillus, specially associated with the intestinal tract and with soil contaminated by excreta, but man must very frequently come into contact with it and take it in with food. The conditions under which it will grow in foods and produce enough toxin to cause symptoms in man have not yet been defined, but they must evidently be seldom realised, for botulism is, and always has been, quite a rare disease.

DEVELOPMENT OF SOME ABERRANT CTENOPHORES.—Prof. T. Komai has recently published studies on two aberrant ctenophores—Cœloplana and Gastrodes (Kyoto; 102 pp.). He has had abundant material of three species of Cœloplana which need no longer be considered a zoological rarity, for the author was able to obtain 50 or 60 *C. bocki* creeping, after the fashion of a planarian, on a single colony of Dendronephthya. He gives a careful account of the anatomy and histology, and shows that the pharynx, at first like that of a Cydippe, becomes divided into two parts—a dorsal, which persists as the pharynx of the adult, and a ventral part which spreads out and forms the surface on which the animal creeps. The eggs are kept under the body of the parent, where they develop and finally hatch as cydippiform larvæ with mouth, pharynx, and canal system. After swimming for about a day the larva begins to remain at the bottom and adheres by or glides on the everted external portion of the pharynx. The cilia of the comb-plates degenerate and the animal, which is henceforward incapable of swimming, gradually becomes flattened. Cœloplana is an extremely modified ctenophore adapted to a creeping mode of life, and its resemblance to a planarian is due to convergence. Prof. Komai has obtained 120 examples of Gastrodes, which lives as a parasite in the mantle of Salpa, and has shown that it enters the Salpa as a planula and grows there into a cydippiform ctenophore about 3 mm. in diameter. It is believed that at this stage it is liberated and sheds its eggs.

FIXATION OF NITROGEN BY THE WHEAT PLANT.—Lipman and Taylor announce (*Science*, November 24) that they have proved conclusively that wheat plants can fix nitrogen from the air in amounts up to 21 per cent. of the total nitrogen content of the plant. The publication of the evidence upon which this startling announcement is made will be eagerly awaited by agricultural research workers, modifying as it does much of the theory upon which current practice in the use of nitrogenous fertilisers is based. The classic researches of Lawes and Gilbert in the eighties of last century have long been deemed to have proved conclusively that the Leguminosæ alone of cultivated plants have the faculty of fixing atmospheric nitrogen, a power which they exercise not directly but through the agency of the nodule organisms on their roots. In their preliminary note in *Science*, the authors recall that one of the heresies maintained many years ago by Jamieson was that all green plants have the power of fixing atmospheric nitrogen (Rept. Agr. Res. Assn., Aberdeen, 1905). It is interesting to note that another of the heterodox views held by this veteran worker was that plants have the power of directly absorbing "insoluble" phosphates. The availability of such substances as plant food is no longer in doubt, and, whatever the mechanism of their entry may be, it is now admitted by botanists and soil chemists that many substances insoluble in water can find their way into plant tissues. Jamieson's facts, therefore, appear to have been right in this case also, although his deductions from them may have been unsound.

TEMPERATURE-RADIATION FROM CLOUDS.—The temperature-radiation from clouds at night is discussed by A. Defant in *Geografiska Annaler* (1922 H. 1.). Some of the radiation that leaves the cloud is absorbed during its descent to the measuring instrument, which is placed on the ground. At the same time the intervening clear air sends out its own temperature-radiation, some of which reaches the instrument. By making allowance for these complications, Defant calculates that a uniform stratus cloud radiates from its lower surface with an intensity almost the same as (actually $2\frac{1}{2}$ per cent. greater than) that of a "full" radiator at the temperature of the cloud. His calculation involves the assumption that the only constituent of the clear atmosphere which radiates energy is the water-vapour. He also reduces observations of the nocturnal cooling of the air at various observatories, and finds that:

(the cooling per hour when w tenths of sky are clouded) = (same quantity when sky clear) $(1 - 0{\cdot}76\, w/10)$.

WATER POWER IN INDIA.—The issue of the Journal of the Royal Society of Arts for December 15 contains the report of a meeting at which a paper by Mr. J. W. Meares on "The Development of Water Power in India" was read and discussed. The paper was largely a condensed account of information collected by the Hydro-Electric Survey of India and published *in extenso* in the Triennial Report of last year. Mr. Meares, as Electrical Adviser to the Indian Government, was associated, first with the late Mr. G. T. Barlow, and later with Mr. F. E. Bull, successively Chief Engineers of the Survey, in the preparation of the report, and in the analysis of data for potential hydro-electric development schemes. The salient results of the investigation were as follows. In the year 1921, some 350,000 e.h.p. had been developed, or was in course of realisation. Sites had been examined which gave satisfactory evidence of a further $1\frac{1}{2}$ million e.h.p. continuously throughout the year. Other sites, not fully examined, were reasonably expected to yield a further $1\frac{1}{2}$ million e.h.p. continuously. Finally, there were sites of which little was known but their existence, the capacity of which was speculatively, but cautiously, reckoned at 4 million e.h.p., so that "it is perfectly safe to say that at least 7 million e.h.p. is in sight on the most conservative estimate and on the basis of *absolute* minimum continuous power." In announcing these results, Mr. Meares deplored the fact that he was practically in the position of delivering a funeral oration on the Survey, which was moribund for lack of financial assistance.

AN ELECTRIC MICROSCOPE LAMP.—We have received from Messrs. Ogilvy and Co., 18 Bloomsbury Sq., W.C.1, a new form of electric microscope lamp, specially designed for research work. An opal electric bulb of the half-watt type is enclosed within a cylindrical metal hood which is practically light proof, though well ventilated. The holder of the electric bulb is provided with a push-bar switch. The base of the metal hood is detachable, and a slot cut in it fitting over a clamping screw with milled head ensures replacement in the correct position. The hood runs on an upright pillar supported on a heavy tripod base, which gives complete stability, and can be clamped by screws with milled heads in any position of elevation and inclination. The light passes through a circular window cut in the metal hood; this is provided with an iris diaphragm, by means of which the size of the source of light may be regulated. A small prismatic optical bench is attached to the front of the base of the metal hood; this carries two adjustable supports on saddle stands. On one of these is a condensing system, provided with centring screws and iris diaphragm, which is hinged so that if required it may be swung out of the optic axis. The other support is a holder for a cell or light filters. By these arrangements perfect centration of the light and "critical" illumination are obtainable. The instrument is beautifully finished and fulfils the purpose claimed for it; the price (12*l.* 10*s.*) is reasonable, though we fear beyond the reach of most microscopists.

AN ARC RECTIFIER.—At the meeting of the French Physical Society on June 16, MM. L. Dunoyer and P. Toulon gave an account of their experiments on the passage of current through an alternating electric arc with one of the electrodes cooled by the circulation of water through it. They find that whatever the material of the cooled electrode the current only flows when that electrode is the anode. They explain this result as due to the inability of the cooled electrode when it is the cathode to emit the electrons necessary to carry the current. The same effect is obtained between a third cooled electrode and either of the two electrodes of an ordinary alternating arc into which it is introduced. With this arrangement it has been possible from an alternating arc at 110 volts taking 2·5 amperes to obtain by means of a transformer in circuit applying an average of 95 volts to a cooled third electrode a rectified current of 90 amperes. The rectified arc is stable, but the rectified current is not yet steady enough for many industrial purposes.

THE GAUMONT LOUD-SPEAKING TELEPHONE.—At the meeting of the Paris Academy of Sciences on November 27, M. L. Gaumont gave an account of his new loud-speaking telephone, and an illustrated article on it appears in *La Nature* for December 16. The vibrating part of the instrument consists of a silk cone of angle 90° on which is coiled from base to summit a fine wire of aluminium, through which the telephonic current is sent. The cone is placed between cone-shaped poles of an electromagnet and its base is attached to one pole by a collar. As the vibrating cone possesses no period of its own, its motions reproduce without distortion those of the membrane which produced the current. These motions are communicated to the air around the instrument through holes bored in one of the pole pieces and through a trumpet-shaped mouthpiece. With a silk cone of 5·5 cm. diameter weighing 1 gram it was possible to make an ordinary speaking voice heard throughout a room holding 6000 persons without any distortion of the sounds. By introducing a triode valve in the circuit the apparatus transmitted the sound 300 metres.

LARGE THERMIONIC VALVES.—At the Institution of Electrical Engineers on December 7 there was an interesting exhibition of 10 kilowatt vacuum tubes, which are recent developments of the thermionic rectifying valve described by Prof. Fleming in 1904. The large 10 k.w. tubes are used for radio transmission and are of two types, the rectifier (two electrodes) and the oscillator or amplifier (three electrodes). The tubes have water-cooled anodes consisting of a copper tube which is fused to the glass bulb by means of a special copper-glass seal. When in action the tube is mounted so that the anode is surrounded by a metal joint through which cooling water circulates. In the 10 k.w. tube the filament current is 24 amperes, the filament voltage is 32, and the normal plate voltage is 10,000. The power taken by the tube, including the losses inside the tube, is 15 kilowatts and the output power delivered from the tube is 10 kilowatts. The perfecting of these large valves will have a great influence on the future development of radio-communication.

Belgian Botany: a Record of War Time.

THE Botanical Institute, close to the Botanic Gardens in Brussels, which bears the name of that distinguished Belgian botanist, Léo Errera, has resumed its activities since the war and is again under the guidance of Prof. Jean Massart of the University of Brussels. A large volume, Part 2 of vol. 10 of the collected papers of the Institute, has recently appeared, published in Brussels, with many plates, text-figures, charts, and maps, together with a list of the communications published in the earlier volumes. Most of the papers have previously appeared in scientific journals in France or Belgium, but we note as apparently new contributions a brief note by Henri Micheels, comparing the effect upon seedling germination of the anions Cl and NO_3 and the cations K and Na, a note reporting the presence of calcium thiosulphate in *Achromatium oxaliferum* Schew by Germaine Hannevart, and a continuation of phenological observations by E. Vanderlinden, meteorologist to the Belgian Royal Meteorological Institute, which is lavishly illustrated by charts, and a description of the vegetation succeeding upon the war-time inundations of the Yser and upon the ruins of Nieuport.

Prof. Massart's earlier studies of the vegetation of the Belgian littoral make him the natural chronicler of the intense subsidiary struggle waged among the vegetation of this region and maintained long after the armistice of 1918. Behind the dunes bordering the Belgian coast there lies a long stretch of country, the level of which is intermediate between the level of the high and low tides of the sea. On October 29, 1914, the Belgian engineers opened the locks at high tide and allowed the sea to flow over this portion of their front, thus preventing the farther advance of the German forces, and giving their own heroic troops a well-earned respite. For four long years these inundations remained upon the land, fully maintained in winter by the natural rainfall and humid atmosphere, in the drier season assisted by the regulated influx of the sea controlled by the Belgian engineer service. Prof. Massart, aided by official photographs and maps, gives a vivid account of the effect of these conditions upon the vegetation, and, by further striking photographs of his own, records the rapid recovery of the vegetation of the region since the salt-water invasion finally ceased at the close of the war (Figs. 1 and 2).

FIG. 1.—Raised footpath near Ramscapelle after retreat of floods, May 1919. Only vegetation, tufts of *Phragmites communis* in distance.

FIG. 2.—Same path in September 1920. Some of supports of original planking left, ground covered with *Aster tripolium* in flower, especially around shell holes on foreground on right.

The vegetation of this region, once wrested from the sea, rapidly succumbed before the salt water—willows, poplars, elms, etc., all dying as the salt tide reached their roots. At Blankaert, where the waters of the Yser diluted the salt water, Massart figures an interesting group of willows which, inundated for more than a metre above their normal root level, have developed a fresh crop of roots at the new water level, increasing the girth of their trunks above this new fringe of roots.

Very few plants replaced the displaced vegetation, and when the water retreated the mud was left bare and desolate. Massart describes the red alga, *Porphyra laciniata*, growing in the brackish water of a shell-hole, but no longer red in colour. Fringing the salt inundation were typical halophytes like *Aster tripolium*, *Atriplex littoralis*, etc. As the waters receded and the former denizens returned to the attack these plants have to retreat—in 1919 in the ascendant throughout the region, 1920 finds them fighting desperately for a foothold upon the salt-incrusted edge of many a shell-hole. Active in the attack upon these war-time invaders is *Agropyrum repens*, a plant the fighting qualities of which are known to many an allotment holder. *Phragmites communis* had maintained itself during the inundation upon occasional islets rising above the general flood level, where it dispossessed practically all other inhabitants trying to maintain themselves before the salt flood. As the mud dries, long slender rhizomes descend from these little knolls and Phragmites eagerly advances to recover its old domain. An interesting observation made by Massart is that as the yellow-flowered halophyte *Aster tripolium*, typical of the salt marsh, recedes before the reconquering flora of the fertile Belgian plain of peace, there is a fringe of the form of this aster with purple-ray florets to be found maintaining itself for a time upon the more fertile, less saline soil. This occurrence of the purple form is being made the subject of further study in a biological laboratory installed upon the Yser.

Another result of the war is that some of the earlier scientific communications, republished from French scientific journals, give the observations made by Prof. Massart in his enforced exile during those tragic years, including a most interesting discussion of the striking features of the Riviera vegetation as they appear to a Belgian ecologist. The reprinting of Prof. Massart's polemical contribution to the *Revue de Paris* of October 1918, "Les Intellectuels Allemands et la Recherche de la Vérité," seems inappropriate in a volume of this nature, but the perusal of this article may be recommended to any British botanists who may have so far failed to realise the difficulties that still lie in the way of any genuine international Botanical Congress, of the type that would have been held in London before the present date if the war had not intervened.

Methods and Costs of Coal-mine Haulage.[1]

By Prof. HENRY LOUIS.

THE series of bulletins issued under the authority of the University of Illinois has achieved an enviable reputation among mining engineers in this country, and the latest addition fully sustains this reputation. Its origin differs slightly from preceding bulletins, inasmuch as it has been prepared under a co-operative agreement between the Engineering Experiment Station of the University of Illinois, the Illinois State Geological Survey, and the United States Bureau of Mines. Incidentally, such a method of work may be recommended to the serious attention of universities in this country; some of them have indeed moved in this direction, but none has gone so far as has the University of Illinois.

The present bulletin could scarcely come at a more opportune moment, seeing that attention in this country is being focussed upon the possibilities of electric locomotive haulage in collieries, and the pamphlet under review contains a full and authoritative exposition of what is being done in one of the most important of the coal-mining regions of the United States, Illinois ranking in coal output next to Pennsylvania, with an annual production exceeding one-third of that of Great Britain. Individual mines, moreover, are very large, seeing that in some of them, as is here stated, "6000 or more tons of coal per day are hoisted in 5-ton capacity cars and that 1200 or more cars per day, or 150 per hour," must be concentrated at the shaft bottom from various parts of the mine; there is nothing on the same scale in this country.

The bulletin is divided into six chapters. The first contains merely a brief introduction and explanation of the scope of the subject. The second chapter deals briefly with the evolution of mine haulage and shows how great has been the change in practice within the last twenty years: "In 1899, 87·1 per cent. of the tonnage in Illinois coal-mines was handled by animal haulage. Locomotives hauled 2·5 per cent., ropes 7·9 per cent., and tramming 2·5 per cent., but in 1921 it appears that both ropes and tramming were practically obsolete and that 91·2 per cent. of the coal was moved by locomotives, and only 8·8 per cent. by animals."

Of the locomotives, by far the greatest number are electric; considerable attention is now being paid to the track, 45- to 60-pound rails being used on the main roads. It appears that the first electric locomotive was tried in a colliery in Illinois so far back as 1888, but their introduction on any scale only came eleven years later. These locomotives were trolley locomotives and could only run on main roads; gathering from the coal face was still mainly done by mules, but in 1900 the cable locomotive was introduced, consisting of a locomotive furnished with a long flexible conducting cable carried on a reel, which enabled it to run on rails not equipped with trolley wires. For steep dips crab locomotives have been used, consisting of a locomotive with a separate motor driving a drum carrying a steel winding rope, by means of which cars could be hoisted up gradients too steep for the locomotive to travel. Another method of getting over the latter difficulty was the introduction of the rack-rail locomotive, similar to the type used on certain mountain railways.

Storage battery locomotives were introduced about 1899, and they have gradually been improved until their use is now very general; they are so built that they are considered quite safe for operation even in gassy mines. Other types of locomotives that are, or have been, used are steam locomotives, compressed air locomotives, and petrol locomotives; curiously enough, the so-called fireless locomotive using superheated water, which is quite popular in German collieries, appears never to have been even considered, although it no doubt presents certain advantages in fiery mines.

The third chapter of the bulletin deals with the lay-out of the shaft bottom; this section is of com-

[1] Engineering Experiment Station, University of Illinois. Bulletin No. 132: "A Study of Coal-mine Haulage in Illinois," by H. H. Stoek, J. R. Fleming, A. J. Hoskin.

paratively little interest to engineers in this country, as the underground arrangements differ so widely from what they do in America. Perhaps the most important point is the reference to skip hoisting, which has been introduced at several important shaft mines since 1918, the skips carrying loads of between 10 and 12 tons. At one of these mines a trial record of 1000 tons was hoisted in an hour, but all appeared to be capable of hoisting 7000 to 8000 tons daily. It must, however, be remembered that Illinois shafts are shallow, the average depth being only 225 ft.

The fourth chapter deals with details of methods of haulage, both on main lines and by gathering locomotives, which travel between the working face and the "partings" on the main lines; where locomotives are used for gathering, the length of secondary haulage ranges from 800 to 2000 ft. The operations are given in much detail and illustrated by tables of running times. It is shown, for example, that in a large colliery, where the average distance hauled on the main track is 4562 ft., a 15-ton locomotive hauls on the average 1035 ton-miles of coal per day and travels 24 miles. Gathering locomotives necessarily do very much less work than a main-line locomotive, the ton-mileage of the former being approximately $\frac{1}{18}$th of that of the latter. This chapter further contains much useful information upon the construction of mine cars, and directs attention to the efforts that have been made to standardise car design and construction. It is interesting to note that an Illinois mine requires about one car for every four tons of coal hoisted per day; in comparing this with British figures, the larger size of the American car and the shorter length of the main roadways must be taken into account. The construction of the colliery track both on main lines and also for secondary haulage is given in some detail.

Underground haulage costs are carefully dissected in the fifth chapter. There is some difficulty in comparing these costs with costs in this country, because in America costs of hoisting appear frequently to be included with those of haulage, under one head of transportation. It should also be noted in studying this chapter that the items of interest on plant and depreciation are not included. There is thus no real comparison possible between the cost of locomotive haulage and that of animal haulage, which in America always means mule haulage. The last chapter deals with accidents, and the importance of the subject is clear from the opening statement that "For the past ten years haulage fatalities have been second in importance only to those from falls." A dissection of the fatalities shows that the greatest number by far is due to men being caught and run over by cars or locomotives; it is interesting to note that in 1920 thirty-five deaths were due directly to the employment of electricity and four to animals, a proportion of approximately nearly 9 to 1, whereas it has been shown that in 1921 there was more than ten times as much coal moved by locomotives, the vast majority of which are electric, as was moved by animals, so that, contrary to what might have been expected, the danger to life attending the use of the two methods may be said to be about equal. The section concludes with recommendations for the prevention of accidents and a series of safety rules for underground haulage.

It will be fairly obvious from the above summary that this bulletin is one of very real value to the mining community, and deserves the most careful study and attention from coal-mining engineers in this country.

Science Teachers in Conference.

Science Masters' Association.

Nearly 350 members of the Science Masters' Association assembled for their annual general meeting at Cambridge on Tuesday, January 2, when, by the kindness of the University authorities, they took up residence in Trinity and St. John's Colleges. In the evening the members assembled in the Large Examination Hall, where the general meeting and presidential address opened a crowded programme of scientific lectures and demonstrations. Responding to a general desire that the president should address the Association on some aspect of that branch of science which is so closely identified with his name, Sir Ernest Rutherford delivered an address on "A Decade in the History of the Electron." He reminded his audience of the characteristic and peculiar behaviour of the alpha particle and the evolution of our present ideas of atomic structure arising from the work of such investigators as Bohr, Laue, Moseley, and others. After referring to the essential features of radioactive disintegration, he passed to the consideration of the effect of the bombardment of atoms with swiftly moving alpha particles and concluded by outlining some more recent work in which he had been engaged: this aimed at throwing light on the mechanism by which electrons are captured, and released, by such particles.

A vote of thanks was proposed by Prof. Smithells, president-elect of the Association, and seconded by Sir Richard Gregory, and the meeting then passed to the election of officers for the ensuing year.

The following two days were largely absorbed by lectures, demonstrations in the various University laboratories, and visits to the University observatory, farm, and colleges; and if the parties visiting the colleges under the guidance of Sir Arthur Shipley, Dr. Rouse Ball, and others, were small, it must be attributed to the concentration of the scientific programme arranged, rather than to a lack of appreciation of the kindness of these gentlemen.

In addition to the presidential address, four lectures were delivered to the Association as a whole. On Wednesday morning, January 3, Prof. Seward, the Master of Downing College, lectured on "A Summer in Greenland," in the course of which he described his experiences during the summer of 1921 when on a tour of the coastal fringe of Greenland for the purposes of studying some of the botanical and geological features. Lantern illustrations accompanied his remarks on the evolution of icebergs, on dyke formations, on Eskimo life, and on the characteristic flora of the country. Prof. Seward, in addition to his description of topographical features, pointed out the remarkable sinkage in the land, and also the probable resemblance between Greenland to-day and England in the Ice Age.

On Wednesday evening the Chemical Lecture Theatre was crowded to hear Sir William Pope on the subject of "Crystalline Liquids." Prefacing his lecture by a short résumé of the properties associated with crystalline structure in the solid form, Sir William Pope proceeded to demonstrate, by the aid of the lantern-microscope, the existence of such a fundamentally crystalline property as double refraction in certain substances in the liquid condition, *e.g.* *p*-azoxyphenetole, *p*-azoxyanisole, and esters of cholesterol. The facile manipulation of these substances and the beauty of the polarisation effects shown on the screen were much appreciated.

Reference was made to the possible connexion between the molecular structure and the exhibition of anisotropic properties, and to the various theories that have been advanced to explain the peculiar properties of these somewhat unfortunately named liquids.

Thursday's activities were inaugurated by a lecture by the Master of Trinity on "The Electron in Chemistry." Sir J. J. Thomson apologised, as a physicist, for encroaching on the domain of the chemist, but added that the difference between chemistry and physics was due to want of knowledge, and that the problem of chemical combination was one of the most outstanding problems in physics. Dalton's Atomic Theory, as such, took no account of the intrinsic structure of discrete particles, and the modern conception of the internal arrangements of the atom dated from the discovery of the electron in 1897. The necessity of postulating a central positive nucleus and the possible arrangements of electrons around this was then discussed, and with the aid of diagrams and data thrown on the screen Sir Joseph reviewed existing knowledge of atomic structure, adequately deduced the existence of two forms of nitrogen, and showed that electrostatic considerations limited the number of electrons in a stable ring to eight. The latter part of his paper was devoted to the fascinating but somewhat intricate problem of chemical combination and the idea of "activated" molecules.

In addition to these lectures members of the Association divided to hear the very interesting and amusing lecture on "The Acoustics of Public Buildings," by Mr. A. Wood, and a lecture, equally attractive in its illustration, on "Coral Reefs in the Pacific," by Mr. F. A. Potts.

The scientific interests of the members were further selectively absorbed on Thursday by a lecture in the Anatomical Department by Dr. H. Hartridge on "Physiological Limits to the Accuracy of Visual Measurements"—a lecture of great interest to physicists among others—proceeding simultaneously with a lecture by Mr. E. K. Rideal on "Molecular Orientation on Plane Surfaces": in this, interesting deductions were made from the assumption that surface energy effects are restricted to a film of unimolecular thickness.

The visitors to the Cavendish Laboratory enjoyed Dr. Searle's demonstration of novel methods of determining physical quantities as well as the exhibit of apparatus used by Maxwell, Raleigh, Kelvin, Stokes, and other pioneer physicists. Prof. Marr prefaced his conducted tour of the Sedgwick Museum by a short lecture on some geological considerations suitable for school treatment, while demonstrations of great interest to those engaged in the teaching of science were set up in the laboratories devoted to chemistry, physical chemistry, metallurgy, botany, physiology, experimental psychology, zoology, mineralogy, and in the new Department of Engineering.

A conversazione in the Large Examination Hall on Thursday evening officially terminated the meeting (although the laboratories were opening on the Friday to provide further opportunities for those desiring to visit them): on this occasion Mr. R. E. Priestley lectured on "Antarctic Exploration with Shackleton and Scott." Mr. Priestley's amusing and thrilling lecture, accompanied by lantern illustration that won frequent applause, provided an appropriate conclusion to a richly stimulating meeting.

It remains to be mentioned that well-known firms held an exhibition of books and apparatus in the Arts School.

Association of Women Science Teachers.

At the annual meeting of the Association of Women Science Teachers held at University College, London, on January 6, a report was received from the subcommittee appointed to investigate the possibility of getting into touch with Colonial and foreign teachers of science. An appeal was made for members to correspond with teachers in other countries, and especially to send scientific journals to them. It is hoped that this movement may be further developed and become a useful part of international co-operation.

In her presidential address Miss M. B. Thomas reviewed the criticisms which have recently been made against methods of teaching science in schools. She pointed out that it was impracticable, under existing conditions, to combine preparation for university entrance examinations with the wide and more generalised scientific instruction which was so generally felt to be desirable, and pleaded for greater co-ordination between the subjects taught in schools. It was obvious that Science, and Languages, English, etc., could be mutually helpful, and that a closer co-operation between the mistresses teaching these subjects would result in advantage to all the subjects.

In the afternoon a large and appreciative audience heard a lecture by Dr. Dorothy Wrinch on "Relativity and Scientific Method." The lecturer gave an exposition of this difficult subject which was so clear that even her non-mathematical hearers could follow the argument. She pointed out that the old dynamics had rested entirely upon the idea of measurement relative to a rigid and stationary standard, and that if the standard moved with a uniform velocity the position of affairs was altered. Examples were quoted in which the new equation for the composition of velocities has solved long-standing problems. Dr. Wrinch then proceeded to apply the principle to various kinds of scientific problems, which must not be approached on the assumption that the old laws would hold good but with the possibility in view that some law of the same nature as that of relativity might be the governing principle. To sum up, it must be remembered that if such apparent fundamentals as time and distance have been shown to depend on velocity, then velocity is a relevant variable in all scientific method.

Hail and Sleet in Meteorological Terminology.

AT intervals there appears in the meteorological literature of various countries a discussion concerning the proper designation of the smaller and softer forms of hail which are common in all European countries during the winter or spring months. A recent contribution to the subject by R. Giacomelli, appearing in the issue for May and June of *La Meteorologia pratica*, the organ of the observatory of Montecassino, near Naples, is illuminating from certain points of view, without really settling the question. It is pointed out that the French and German terms, *grésil* and *gräupel* respectively, have the root idea of little pellets or grains, and that the real Italian equivalent, *gragnola*, is meteorologically a better descriptive term since it means "little hail." In full keeping, moreover, with the almost amusing richness of the Italian language in diminutive terms, one may use in place of *gragnola* the words *granzola*, *granuschia*, *gragnolischia*, all of which are derived from *grandinola* (*grandine*, hail), and each of which is locally favoured in various parts of central Italy, where such forms of frozen precipitation are fairly frequent in the spring period, March and April.

In English we have no distinctive word, nor, as it is hoped to show in this note, do we really need one. The familiar word "sleet" appears to follow the German *Schlacken* in denoting a mixture of rain and snow in the British Isles; but in the United States "sleet" is officially reserved for true frozen rain, that is to say, drops which congeal into clear ice spherules by passing through a cold surface stratum of air. This kind of hail, as one would categorise it in England, is a common winter phenomenon in the eastern States, because there the contrasts of temperature between the equatorial and polar currents in cyclones, though not more frequent than in England, are more violent, so that a warm rain more often than here alights on a frozen soil. But, on the other hand, various forms of wintry hail falling in showers in moderately cold polar currents during the winter and spring are distinctly common in England, and these show almost every gradation from the little soft white opaque pellets, which are really hardened snowflakes and might be called "snow-hail," to something very like the real hail more typically associated with summer thunderstorms. It is clear that ambiguity would arise if "sleet" were used for any of these forms in this country. In fact, the British official practice of comprising all forms of frozen precipitation other than snow under the term "hail" is philosophically sound, and no regret need really be felt that we have no word to correspond to *grésil*, *gräupel*, or *gragnola*. It would appear that the only real solution of this terminological difficulty is to recognise but three fundamental species of precipitation: "rain," the liquid form; "snow," the frozen form in flakes or dust; and "hail," the frozen form in stones or pellets.

Actually, the different varieties of hail scarcely differ more from one another than do the different varieties of snow, or even of rain, and no difficulty need be felt on that score. Doubtful forms, such as the "snow-hail" referred to above, had best be entered in a register to both species; and in the case of the mixture of rain and snow, which in this country we call "sleet," this is habitually done. The double-entry plan has the advantage of tending to eliminate the effect of personal bias on the part of an observer, a factor which probably affects quite seriously the comparability of snow-frequency statistics in different localities. L. C. W. B.

The International Astronomical Union.

VOLUME I. of the Transactions of the International Astronomical Union, giving an account of the first general assembly held at Rome, May last, is edited by Prof. A. Fowler (London: Imperial College Bookstall, Prince Consort Road, S.W.7; price 15*s*.). It is an indispensable book of reference for astronomical workers, which contains the agenda of the thirty-two commissions, including important proposals for the co-ordination of methods of observing and mapping out of the fields of work to avoid useless duplication. The spectroscopic data are particularly full: the Draper spectral notation has been slightly modified and considerably extended in the light of increased knowledge. The letter Q is assigned to novæ, and the well-known stages in the development of the nova spectrum are indicated by suffixes. There is also a list of wave-lengths of iron, neon, and other lines suggested as standards.

Some of the decisions may be given briefly. The Latin names of the constellations are to be used, and a set of 3-letter abbreviations of these names was agreed to. The kilometre is to be used for line-of-sight velocities and for dimensions of bodies, the astronomical unit for planetary distances, the parsec for stellar distances. Absolute magnitude is defined as the magnitude at a distance of 10 parsecs. Certain letters were formerly used with several different meanings; they are now distinguished thus: [A] = a line in the spectrum, A̲ or *A* (ital.) = Argon, A = a stellar spectral type.

The *Conn. des Temps* list of Fundamental Stars and the *Carte du Ciel* list of intermediary stars were adopted as standards, and 1925·0 is to be used as the standard equinox up to 1940. M. Andoyer undertook to reduce the latest positions of the fundamental stars to this equinox.

It was recommended that the short-period variations in solar radiation, announced by Abbot, should be studied as widely as possible, and their correlation with weather changes investigated.

Photometric work on minor planets was recommended. In stellar-parallax work it was recommended that plates of each field should be repeated after 10 years, to obtain the proper motions of the comparison stars.

A central bureau for double-star work was recommended, and various decisions for securing uniformity of method were passed. A variable star bureau or centre in each country is desirable (one has been established at Lyons). The Cracow Observatory undertakes the preparation of ephemerides of Algol stars.

The commission on calendar reform recommended (1) a perpetual calendar, with a 52-week year and one or two days outside week and month, (2) the lengths of the months in each quarter should be 30, 30, 31 days, and (3) that the year should begin at the winter solstice.

The volume is thus a noteworthy record of important decisions, embracing nearly every branch of astronomy.

The Haber Process.

THE lecture delivered by Prof. F. Haber on the award of the Nobel Prize at Stockholm on June 1, 1920, is printed in *Die Naturwissenschaften* for December 8. Prof. Haber dealt first with the work done on the synthesis of ammonia before his first research in 1905. Practically nothing of importance had come to light, and the very small yields at ordinary pressures did not hold out much promise of technical application.

The early experiments of Haber, like most of those which have served as the foundations of great industrial undertakings, were made with a purely scientific object, and with no technical applications in view. The results obtained, however, soon made it clear that the basis of an important technical process could be found in ammonia synthesis, and further work was undertaken with this end in sight.

In 1908 the Badische Gesellschaft placed at Haber's disposal all the means requisite for the further progress of the research on the synthesis of nitric oxide in the electric arc which he had begun in 1907, but his proposal to undertake research on the synthesis of ammonia was received with open doubts as to the potential value of the method. The nitric oxide syntheses, in cooled arcs under reduced pressure, and in flames and explosions, were not found suitable for technical application, and attention was then turned to the stone which the builders had rejected. The judgment of the technical chemists of the Badische Gesellschaft had been at fault, since ammonia synthesis was ultimately a very real solution of the problem of the economic utilisation of atmospheric nitrogen.

Ramsay and Young in 1884 had found that with nitrogen and hydrogen in presence of iron at 800° C. no ammonia was produced. This was found to be incorrect, and traces of ammonia were detected. Other catalysts were tried, and from the results it was evident that an equilibrium state was attained, from which it was possible to calculate the yields at other temperatures and pressures. No further progress was made, however, since it was judged by the technical experts to be impossible to carry out the reaction on the large scale at the temperatures required under the very high pressures indicated by the calculations.

In 1906 measurements under pressure were for the first time carried out by Nernst and Jellinek (these are not referred to by Haber), and in 1908 Haber in conjunction with Dr. Le Rossignol began experiments at higher pressures. The work of Le Rossignol (a British subject) is spoken of with great approbation, although his part in the achievement of success has perhaps not always received full credit in some quarters. The technical chemists were still unfavourably inclined towards the process, although practical yields had now been reached: it was clear that "es eines eindrucksvollen Fortschrittes bedurfte, um das technische Interesse für das Gegenstand zu wecken." By the use of new catalysts the temperature was lowered to 500-600° under a pressure of 200 atmospheres. In 1913 the process was taken up by the Badische Gesellschaft, but an account of the main scientific results was also published. The work of Dr. Bosch speedily led to the successful introduction of the synthetic ammonia process, and in the period 1913–1920 the capacities of the German factories rose from *nil* to 35,000 tons per annum in 1914, 850,000 tons in 1918, and 1,500,000 tons in 1920.

University and Educational Intelligence.

CAMBRIDGE.—The annual report of the General Board of Studies on certain University departments shows much useful work being done both in instruction and research. Here we must limit ourselves to some of the new features. (1) It is announced that the enlargement of the Small Animal Breeding Research Institute with help from the Ministry of Agriculture has been followed by a proposal to place at Cambridge a Horticultural Research Station set up by the Ministry in conjunction with the growers. (2) The formation of the Cambridge Architects' Club to unite former members of the University within the profession in support of the School of Architecture is not valuable merely to the department concerned, but may react favourably in several ways on all departments of the University. (3) Research work is being carried out on aerial surveying, also on the measurement from aeroplanes of the altitude of the sun by means of gravity-controlled sextants, the aeroplanes and pilots being provided by the Air Ministry for work under the direction of the professor of aeronautical engineering. (4) The exhibit made by the School of Forestry at the Royal Agricultural Society's Show was awarded the Society's special gold medal.

LONDON.—A number of free public lectures have been arranged for the Lent term at King's College, Strand. A course of eight lectures, on Wednesdays, at 5.30 P.M., commencing January 24, on "Some Aspects of Natural Philosophy," will be given, and the following, in the order named, have promised to lecture: Prof. A. N. Whitehead, Sir Frank Dyson, Dr. J. S. Haldane, Dr. Dukinfield Scott, Prof. F. Soddy, Principal L. P. Jacks Sir Herbert Jackson, and Sir Richard Gregory. Prof. H. Wildon Carr is giving six lectures on "Physical Causality and Modern Science" on Tuesdays, at 5.30 P.M., beginning February 20. In the department of psychology, Dr. William Brown is giving a course of three lectures on "Psychology and Psychotherapy" on Mondays at 5.30 P.M., commencing February 19. There is also a course of six lectures by Prof. V. Barthold, of the University of Petrograd, on "The Nomads of Central Asia," on Thursdays, which commenced on January 18, and three lectures, by Dr. J. H. Orton, on February 20, 22, and 23, at 5.15 P.M., on "The Bionomics of Marine Animals."

At University College, a course of ten public lectures on "The Micro-organic Population of the Soil" will be given by Sir John Russell and the staff of the Rothamsted Experimental Station in the lecture theatre of the Botanical department of the College, at 5 o'clock on February 5, 7, 12, 14, 19, 21, 27, and March 1, 5, and 7. Dr. G. Anrep is also to deliver a course of eight public lectures at the College, at 5 o'clock, on January 26, February 2, 9, 16, 23, and March 2, 9, and 16, on "The Physiology of the Cortex as investigated by the Method of Conditioned Reflexes." No tickets will be required for either of these courses.

THE Board of Education announces that the Imperial Education Conference is to be held in London in June next. The last meeting was held in London in 1911, and, but for the war, the conference would have met in 1915. The conference will be attended by official representatives from the Education Departments of the self-governing Dominions and Colonies and the British Isles, and various matters of common interest will be discussed, including the question of the interchange of teachers within the Empire.

THE trustees of the Albert Kahn Travelling Fellowships will elect one fellow in May or June next. These fellowships were established by M. Albert Kahn, of Paris, in order to enable suitable persons to undertake a year's travel round the world with the view of obtaining an unprejudiced survey of various civilisations and the acquisition of a generous and philosophic outlook on life. The value of the award for this year will be between 900*l.* and 1000*l.*, the exact amount being decided at the time of election. Candidates may be of either sex, but must be British subjects and graduates of a university of Great Britain or Ireland. The vice-chancellors of these universities, and the presidents of the Royal Society and the British Academy, may each nominate one candidate. Nominations must be sent in by February 28.

PROF. BOHUSLAV BRAUNER writes:—"John Gerald Frederick Druce, senior science master at Battersea Grammar School, London, has obtained the important degree of 'Doctor Rerum Naturalium' of the Charles' University, Prague, after having passed his examinations, which were conducted in English and French, 'summa cum laude.' Dr. Druce is the first Englishman to take this degree in the Charles' (Bohemian) University of Prague. This is the beginning of new scientific connexions between the Czech and English nations. *Vivant sequentes.*"

Societies and Academies.

LONDON.

Royal Microscopical Society, December 20.—Prof. F. J. Cheshire, president, in the chair.—J. E. **Barnard**: Sub-bacteria. The name "Sub-bacteria" is suggested for that group of presumably living organisms which are usually referred to as "filter passers" or "ultra-microscopical viruses." The term may be justified on the grounds that such organisms are of the same order of size as colloidal particles known as sub-microns. Filters are of variable and often unknown porosity, and it is therefore more satisfactory to let the microscopical limits of resolution be the standard beyond which the title suggested may be applied. For the investigation of bodies beyond the limits of microscopical resolution but still within the limits of visibility by suitable illumination, the improbability of any staining method proving of value was insisted on, particularly those involving prolonged fixation processes in which the so-called staining is in reality a deposition of material on the exterior of the object.—H. J. **Denham**: A micrometric slide rule. When one or more micrometer eyepieces are employed with several objectives, a simple nomograph may be used to convert the eyepiece measurements into known units of length. The slide rule described consists of such a nomograph fitted with a movable cursor, which is engraved with an eyepiece scale enlarged ten times. Oblique rulings on the body of the scale represent the rulings of a stage micrometer. The scale is calibrated by trial of the various combinations of eyepiece and objective likely to be used (at standard tube length) on a graduated stage micrometer: to use it, the movable cursor is set to the predetermined position for the combination of eyepiece and objective employed, and the eyepiece measurement is read off in terms of the stage micrometer, while the magnification may be read off the graduated lower edge of the rule. Correction for alterations in tube length without recalibration may be made by the help of a second nomograph on the back of the slide rule.—J. R. **Norman**: Methods and technique of reconstruction. Some of the methods employed for building up a model of any object which has previously been cut into sections in a definite plane are described. The Graham Kerr method consists in making coloured drawings of the sections on ground-glass plates; the plates are then fitted together, and a model obtained by rendering them transparent by immersion in a suitable medium. In the so-called "plastic" method invented by Born, which appears to be in general use, the sections are drawn on plates made of some form of wax, their outlines cut out, and the wax sections fixed together to form a solid model. The technique of preparing the models is described and a new wax mixture formulated.

PARIS.

Academy of Sciences, December 26.—M. Emile Bertin in the chair.—Pierre **Termier**: The structure of the eastern Alps; origin of the superalpine sheet; the problem of the age of the large strata.—A. **Blondel**: The electro-phonographic method and its use for the registration of sounds. The author described in 1911 a method of sound recording based on the combination of the microphone and oscillograph, and this was modified in 1915 for use under war conditions. An imperfect form of this was utilised, without acknowledgment, by the French army.—C. **Guichard**: Conjugated networks.—Edouard **Imbeaux**: The fountain of youth (Silver Spring). A description (with photograph) of Silver Spring, Florida, with a geological section showing its relationship with Blue Spring, 26 miles distant.—Alf. **Guldberg**: Some inequalities in the calculus of probabilities.—Bertrand **Gambier**: Linear systems of plane curves admitting a given system of base points.—Georges **Bouligand**: A concept of linear geometry.—Nilos **Sakellariou**: Polar figures.—A. **Petot**: Motor-cars with transmission by a longitudinal Cardan shaft.—M. **Maggini**: Anomalous dispersion in stellar spectra. Studies on anomalous dispersion may serve as a qualitative test of the theories of Lockyer and Schuster on the evolution of stars.—J. **Le Roux**: Newton's mechanics is not an approximation of that of Einstein.—F. **van Aalst**: The maintenance of electrical oscillations by a lamp with three electrodes. Experiments confirming the formula expressing the necessary condition for the maintenance of oscillations.—A. **Druault**: The diffraction spectra produced by round corpuscles irregularly distributed. Three classes of round corpuscles were used in these experiments, lycopodium grains, powder from diseased wheat, and red-blood corpuscles. The existence of a maximum of diffracted light not predicted theoretically is shown.—H. **Weiss** and P. **Henry**: Diffusion in solid solutions. A study of the interdiffusion of gold and silver at temperatures of 935° C., 885° C., and 835° C. The diffusion constant found agrees well with the earlier figure of Fraenkel and Houben at 870° C.—F. **Bourion** and E. **Rouyer**: The application of the method of continuous variations to boiling-point phenomena for the determination of double salts in solution.—Marcel **Delépine**: The *cis* and *trans* iridio-dichloro-dioxalates. The optical resolution of the *cis* potassium salt.—Marcel **Godchot** and Pierre **Bedos**: The oxide of Δ_3-methylcyclohexene and the dimethylcyclohexanols. The ether oxide can be obtained from the hydrocarbon Δ_3-methylcyclohexene either by direct oxidation with perbenzoic acid or by conversion into the iodohydrin and subsequent treatment with caustic potash. The ether oxide is converted into the corresponding diol by heating with water for six hours at 130° C.—Paul **Gaubert**: The polymorphism of antipyrine, vanillin, and the erythrites.—M. **Lecointre**: The palæozoic strata of the region north-west of Zaër (Western Morocco).—Georges **Corroy**: The Valanginian of the eastern border of the Paris basin.—M. **Boit**: The morphology of the Bas-Morvan.—Marc **Dechevrens**: Two categories of earth currents. A discussion of various observations from 1851 onwards from the point of view of the influence on the moon on telluric currents.—C. **Dauzère**: Researches on natural coloration effected at the Pic du Midi according to the experiments of J. Bouget. The intense colorations of flowers at high altitudes are ascribed to the same cause as the permanent coloration of glass exposed in similar positions.—Ph. **Flajolet**: Perturbation of the magnetic declination at Lyons during the year 1921–22.—R. **Dongier**: Magnetic measurements in the south-east of France (left bank of the Rhône).—L. **Blaringhem**: Hereditary mosaic in the pea (*Pisum sativum*).—René **Souèges**: The embryology of the Malvaceæ. The development of the embryo in *Malva rotundifolia*.—E. and G. **Nicolas**: The influence of formaldehyde on the higher plants. When chlorophyll is absent, or present in insufficient quantity, formaldehyde exerts a toxic action on plants: when the chlorophyll can act as a photocatalyst the influence becomes favourable to growth.—Manuel **Sánchez y Sánchez**: The nature and function of the reticular apparatus of Golgi. The process of oxidation in the plant cell and the development of the network of Golgi increase together;

hence it appears probable that in the Golgi apparatus ferments indispensable to the nutrition and development of the cell are produced.—H. **Colin** and H. **Belval**: The genesis of the carbohydrates in wheat. The presence of levulosanes in the stem.—C. **Champy**: The fluctuating appearance of the male sexual characters in the female *Triton alpestris*.—Edouard **Chatton** and André **Levoff**: The evolution of the infusoria of the lamellibranchs. Relations between the Sphenophryidæ and the Hypocomidæ.

Official Publications Received.

Bulletin of the Imperial Earthquake Investigation Committee. Vol. 8, No. 6: The Sakura-jima Eruptions and Earthquakes, VI. By F. Omori. Pp. 465-525+plates 88-107. (Tokyo.)

Bulletin of the Geological Institution of the University of Upsala. Vol. 18. Edited by Hj. Sjogren. Pp. xxvii+269+6 plates. (Uppsala: Almquist and Wiksells Boktryckeri-Aktiebolag.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 11, Part 2: Flora of the Island of Paramushir. By Yushun Kudo. Pp. 23-183. (Sapporo.)

The Work of the Chemical Examiner's Department in the Punjab. By Lt.-Col. J. A. Black. Pp. 23. (Lahore: Civil and Military Gazette Press.)

The Marine Biological Station at Port Erin: Being the Thirty-Sixth Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 52. (Liverpool.)

Meteorology in Mysore for 1921: Being the Results of Observations at Bangalore, Mysore, Hassan and Chitaldrug. Twenty-ninth Annual Report. By N. Venkatesa Iyengar. Pp. iii+15. (Bangalore: Government Press.)

Mysore Government: Meteorological Department. Report on Rainfall Registration in Mysore for 1921. By N. Venkatesa Iyengar. Pp. xvii+35. (Bangalore: Government Press.)

Diary of Societies.

SATURDAY, JANUARY 20.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11 A.M.—Dr. W. Brown and Dr. A. S. Horne: Fusarium.—J. Ramsbottom: Berkeley and Broome.—Miss W. Ridler: The Fungus present in *Lunularia cruciata*.—Dr. H. Wormald: Crown-Gall in Nursery Stock.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Walford Davies: Speech Rhythm in Vocal Music (1).

MONDAY, JANUARY 22.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—P. Lake: Wegener's Hypothesis of Continental Drift.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—A. G. Warren and others: Discussion on Insulators and Insulating Materials.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—Informal Discussion on The Value of College Training to Engineers.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—R. Knott and W. E. Riley: The London County Hall.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Sir William Willcox and others: Discussion on Dental Sepsis as an Ætiological Factor in Disease of other Organs.

TUESDAY, JANUARY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. F. G. Donnan: Semi-Permeable Membranes and Colloid Chemistry (2). Relation to Problems of Colloid Chemistry and Biology.

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Film illustrating Industrial Works.—Messrs. Beardmore, Ltd.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. C. Tilney: Address.

ROYAL ANTHROPOLOGICAL INSTITUTE (Anniversary Meeting), at 8.15.

WEDNESDAY, JANUARY 24.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Rev. C. Overy: The Glacial Succession in the Thames Catchment-Basin.—Dr. S. H. Haughton: Reptilian Remains from the Karroo Beds of East Africa.

WOMEN'S ENGINEERING SOCIETY (at 26 George Street, Hanover Square), at 6.15.—Miss V. Holmes: Mechanical Injection of Fuel as applied to Diesel Engines (to be followed by a Discussion).

ROYAL MICROSCOPICAL SOCIETY (Section dealing with the Industrial Applications of the Microscope), at 7.—Inaugural Meeting.—Prof. F. J. Cheshire: Opening Address.—Dr. F. J. Brislee: Training in Practical Microscopy and the Necessity of providing Facilities for more Definite Instruction.—Dr. J. S. Owens: Atmospheric Pollution.—Demonstrations.—Exhibits.

ROYAL SOCIETY OF ARTS, at 8.—Sir William Henry Bragg: The New Methods of Crystal Analysis, and their Bearing on Pure and Applied Science ("Trueman Wood" Lecture).

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine, 1 Wimpole Street), at 8.30.—Dr. W. Brown: Autosuggestion and Transference.

THURSDAY, JANUARY 25.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Prof. A. V. Hill: The Potential Difference occurring in a Donnan Equilibrium and the Theory of Colloidal Behaviour.—Dr. E. F. Armstrong and T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces. X. The Interaction of Carbon Monoxide and Hydrogen as conditioned by Nickel at relatively low Temperatures. A Practical Synthesis of Methane.—Dr. J. Holker: The Periodic Opacity of certain Colloids in progressively increasing Concentrations of Electrolytes.—E. K. Rideal and R. G. W. Norrish: The Photochemistry of Potassium Permanganate. Part I. The Application of the Potentiometer to the Study of Photochemical Change. Part II. On the Energetics of the Photo-decomposition of Potassium Permanganate.—E. A. Fisher: Some Moisture Relations of Colloids. I. A Comparative Study of the Rates of Evaporation of Water from Wool, Sand, and Clay.—R. Whytlaw-Gray, J. B. Speakman, and J. H. P. Campbell: Smokes—A Study of their Behaviour and a Method of determining the Number of Particles they contain.—R. Whytlaw-Gray and J. B. Speakman: A Method of determining the Size of the Particles in Smokes. Part II.—R. C. Ray: The Effect of Long Grinding on Quartz (Silver Sand).

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—W. Day: The Birth of Cinematography and its Antecedents.

INSTITUTION OF STRUCTURAL ENGINEERS (at 296 Vauxhall Bridge Road), at 7.30.—W. J. H. Leverton: The Relations between the Architect and the Engineer.

CAMERA CLUB, at 8.15.—W. Wrench: Our Old Village Churches and their Story.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Clinical and Pathological Meeting.

FRIDAY, JANUARY 26.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Prof. R. T. Leiper: The Study of Helminthology.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Special Clinical Meeting.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—J. J. Manley: A Further Improvement in the Sprengel Pump.—Dr. C. Chree: A Supposed Relationship between Sunspot Frequency and the Potential-Gradient of Atmospheric Electricity.—Dr. D. Owen: Null Methods of Measurement of Power-Factor and Effective Resistance in Alternate-Current Circuits by the Quadrant Electrometer.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—G. F. Shotter: K.V.A. and its Measurement.

ROYAL SOCIETY OF MEDICINE, at 8.30.—Special Meeting to commemorate the Centenary of the Death of Edward Jenner.—Sir W. Hale-White: Jenner and his Work.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Almroth Wright: The Machinery of Anti-Bacterial Defence.

SATURDAY, JANUARY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Walford Davies: Speech Rhythm in Vocal Music (2).

PUBLIC LECTURES.

MONDAY, JANUARY 22.

IMPERIAL INSTITUTE, at 3.—Miss Edith Browne: West Africa and Empire Production. (Succeeding Lecture on January 29.)

TUESDAY, JANUARY 23.

IMPERIAL INSTITUTE, at 3.—Col. M. C. Nangle: The Empire in the Far East. (Succeeding Lectures on January 24, 30, 31, February 6, 7, 13, 14, 20, 21, 27, 28, March 6, 7, 13, 14, 20, 21, 27, and 28.)

SOCIOLOGICAL SOCIETY (at 65 Belgrave Road), at 4.45.—Dr. C. W. Saleeby: Sunlight and City Life.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakley: The Enigma of Socrates. (Succeeding Lectures on January 30 and February 6 and 13.)

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on January 24, 25, and 26.

WEDNESDAY, JANUARY 24.

KING'S COLLEGE, at 5.30.—Dr. A. N. Whitehead: The Quest of Science To-day, and as exemplified in its History.

FRIDAY, JANUARY 26.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: Forecasting Weather. (Succeeding Lectures on February 2, 9, 16, 23, and March 2, 9, 16, 23.)

UNIVERSITY COLLEGE, at 5.—Dr. G. Anrep: The Physiology of the Cortex as investigated by the Method of Conditioned Reflexes. (Succeeding Lectures on February 2, 9, 16, 23, and March 2, 9, and 16.)

SATURDAY, JANUARY 27.

HORNIMAN MUSEUM (Forest Hill), at 3.30. Capt. W. H. Date: Wireless Telephony and Broadcasting.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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NO. 2778, VOL. 111]

The Science and Practice of Pure Milk Supply.

I.

THE history of our milk supply, especially when considered in relation to the corresponding history of the milk supply of the United States, illustrates more intimately, perhaps, than any other subject the necessity for the man of science to study the practical problems involved in the application of his discoveries, and for the administrator and the producer and trader to acquaint themselves with the added responsibilities and increased possibilities of improved trade bestowed by science.

We are chiefly concerned in NATURE with the scientific aspects of the milk problem; but at every stage these are interlocked with practical problems requiring the expenditure, or more correctly the investment, of much money to ensure the health of the community. A statement of some of the considerations involved will make these points clear.

The first point we make is frequently overlooked. An increase in the quantity of milk available for the general public, and particularly for children, is even more important than improved quality of the milk, though this also is a public health requirement of the first grade. In this country far too little milk is consumed. Biologists and chemists have demonstrated that no other food is so vital to the welfare and health of mankind as milk. McCollum, of Baltimore, has laid down the rule that every growing child should be allowed one quart of milk daily, and Lusk states that "no family of five should buy meat until they have bought at least three quarts of milk" daily. In Great Britain not half as much milk is consumed per head as in the United States, and it is to the lack of this element in the dietary of children that a large share of the common malnutrition and undergrowth, and the associated excessive proneness to disease is ascribable. There are abundant instances in which the daily giving of half a pint of milk to each child attending school in poor neighbourhoods has been followed by a marked raising of the general standard of health.

The above statement that an adequate quantity is even more important than an improved quality of milk, although it truthfully represents a neglected aspect of the milk problem, is obviously subject to the condition that milk of the present quality must be made safe either by pasteurisation on the large scale or by bringing it domestically near the boiling point.

Alongside of educational propaganda in favour of purer milk there is needed steady and persistent instruction through child welfare centres, in schools, and generally, to induce parents to spend on milk the greater part of the money now devoted to beer. At the present time three times as much is spent by the British public on alcoholic drinks as on milk, and to this avoidable physiological impoverishment of the children, which is associated with the deficiency of milk, we can in large measure ascribe the proneness to catarrhs and the development of bronchitis, of rickets, and of tuberculosis.

Early, then, in any attempts at practical reform must be placed the need for educating the public into willingness to buy more milk—at least twice or three times as much as is now being bought, for daily dietetic use. It follows that any measures proposed for the purification of milk must be tempered by consideration of the degree of risk to health, the administrative practicability of the proposals, and the expenditure involved.

The necessity for milk sanitation, as for general sanitation, was first impressed on the public mind by the occurrence of epidemics attributed to contaminated milk. It was in 1857 that Dr. W. M. Taylor, of Penrith, traced an epidemic of typhoid fever to contaminated milk, and ten years later he traced an outbreak of scarlet fever to milk. In 1880 Mr. Ernest Hart collected accounts of fifty epidemics of typhoid, fifteen of scarlet fever, and four of diphtheria traced to infected milk supplies; and since then the number has become immensely greater, until, in recent years, commercial pasteurisation combined with a modicum of sanitary precautions on the farm and in the retailing of milk has been associated with a great decrease in the number of such outbreaks. In addition, septic sore throats have not infrequently been traced to milk derived from cows with udder inflammations; and, most important of all, a considerable proportion of human tuberculosis, especially in young children, has been attributed to milk.

The history of the relation of human to bovine tuberculosis is an interesting chapter in bacteriology. In 1896 Theobald Smith announced that the tubercle bacillus of cattle differed materially from that of human tuberculosis. In 1901 Koch made the sensational announcement in London that bovine tuberculosis did not infect human beings. Inasmuch as, prior to this statement, the stress of anti-tuberculosis agitation had been much more against bovine than against human sources of infection, Koch's dictum necessitated a re-investigation of the entire subject. A Royal Commission was appointed, and continued its inquiries for many years. The results of these and of many collateral investigations may be summed up in the statement that bovine tuberculosis undoubtedly does occur in the human being, but that it is a minor cause of human tuberculosis. Furthermore, that, unlike infection of human origin, bovine infection can be effectively prevented—as can also the infection of such occasionally milk-borne diseases as scarlet fever, typhoid fever, and diphtheria,—by pasteurisation of milk, or by bringing milk domestically "just to the boil."

It was tuberculosis in the young subject which was regarded as chiefly caused by milk infection, but experimental observation of the type of bacillus found in children's tuberculous lesions has shown that less than one-third of tuberculosis in children under five years of age is of bovine origin, the greater part being derived from infection of human source. The abdominal tuberculosis and tuberculosis of joints and bones and of glands, which may be due to infection of bovine source, are often not fatal; and it appears likely that, as Cobbett[1] has estimated, the mortality caused by infection with the bovine type of tubercle bacillus *at all ages* is not more than six per cent. of that caused by bovine and human types of bacillus combined. This estimate was made several years ago. The proportion of human mortality from tuberculosis due to bovine infection is probably less now, for one of the striking features of tuberculosis mortality is its recent reduction at ages under five. Thus the death-rate from tuberculosis per million living at ages under five was 1213 in 1920, as compared with an average rate of 1883 in 1912–14. Inasmuch as only a relatively small proportion of this mortality in the earlier period was caused by infected milk, the main credit for the decline, after making any needed allowance for changes in medical certification, must be given to the diminution of human infection; and the entire result can reasonably be regarded as the joint product of measures for diminishing bovine tuberculosis, which, speaking nationally, have been on an extremely small scale, of measures for rendering bovine infection impotent (pasteurisation of milk and domestic heating), and of measures directed chiefly against human adult sources of infection. We have mentioned the six per cent. as a possible limit of the proportion of total tuberculosis mortality at all ages which is due to bovine infection, without intention to minimise its importance, for the annihilation of tuberculosis of bovine origin would greatly reduce the mass of human suffering, and this end is within reach by easily practicable measures, which would serve the interest of dairymen as much as that of the consumers of milk.

The possibility of acquiring tuberculosis or an acute infectious disease like scarlet fever, although the chief, are by no means the sole risks of contaminated milk. Past experience has shown an intimate association between an impure milk supply and excessive infant mortality; and the remarkable reduction in

[1] L. Cobbett. "The Causes of Tuberculosis," Cambridge University Press, 1917.

infant mortality in the present century in this and in other countries has been associated with marked improvement in the cleanliness of milk, commercially and domestically. At each step scientific investigations have been important means to this end. The determination of the thermal death-point of pathogenic bacteria has shown the possibility of heating milk to a lower point than boiling, which, while removing the possibility of infection, leaves milk with its natural taste almost unimpaired. The bacterial counting of milk, showing the close association between cleanly milking followed by immediate cooling of milk and a sparse bacterial count has given a great impetus to the supply of clean and cool milk, especially in America. The tuberculin test has been largely utilised as a means of discovering clinically undiagnosable tuberculosis in cattle, and of its elimination from herds. It is a condition of the official granting of a certificate of production of "Grade A (Tuberculin Tested)" Milk, in accordance with a recent Order of the Ministry of Health. The discovery in 1890 of Babcock's simple method of fat determination has had far-reaching consequences in securing high standards of food value in milk supplies, and in enabling the public when they desire to buy milk of known value. The list of items of indebtedness of the public and of milk purveyors to scientific laboratory workers might easily be extended.

In England there is a large excess of infant deaths in the three hottest months of the summer, and these are due in the main to diarrhœa. To discuss adequately the factors of heat, of impurity of food, of impurities apart from food (*e.g.* exceptionally in breast-fed babies) which are responsible for this devastating disease would require much space; but the following determined facts can be stated. Diarrhœa is rare in breast-fed infants; it is exceptional among the infants of the well-to-do, who can take adequate precautions in respect of food; but it is common in the infants of the poor, and has been found to be more common in infants fed on condensed milk than in infants fed on fresh cows' milk. This does not apply to dried or desiccated milk, infants consuming which appear to suffer much less from diarrhœa than infants artificially fed with other foods. The explanation of these facts is not far to seek. Domestic contaminations of milk are even more important than contaminations at the farm, in transport, or in the local shop, though these also are serious. Condensed milk is difficult to manipulate in a cleanly manner, dried milk is not so. Fresh milk can be more easily provided and, when domestically pasteurised, has been shown to be less liable to cause gastro-intestinal trouble in the summer months than diluted condensed milk. The details showing the need for aseptic precautions in milk preparation, all based on the science founded by Pasteur and applied by Lister, can easily be understood. In the last seventeen years active steps have been taken to instruct and guide mothers in the right feeding of their infants, and there can be little hesitation in ascribing the lowered infant mortality in large measure to this cause, and to the collateral general improvement in the milk as delivered at the home. This improvement has consisted largely in the increasing practice of commercial pasteurisation. Prior to 1900 the rate of infant mortality averaged 140 to 160; in the last quinquennium it was only 85 per 1000 births.

The above consideration of evils and of possible channels of improvements naturally leads to a consideration of the administrative aspect of the problem. This in the main consists in the application of scientific methods to the milk industry, which will be discussed in our next issue.

Progressive Meteorology.

Board of Education. Catalogue of the Collections in the Science Museum, South Kensington, with Descriptive and Historical Notes and Illustrations: Meteorology. Pp. 107+6 plates. (London: H.M. Stationery Office, 1922.) 1*s.* 6*d.* net.

Air Ministry: Meteorological Office, London. A Short Course in Elementary Meteorology. By W. H. Pick. (M.O. 247.) Pp. 118. 1*s.* 6*d.* net. *The Observer's Handbook.* Approved for the use of meteorological observers by the Meteorological Office, and the Royal Meteorological Society. 1921 edition. (M.O. 191.) Pp. xxx+140+18 plates+10+17 plates+5. 7*s.* 6*d.* net. *Cloud Forms according to the International Classification: The Definitions and Descriptions approved by the International Meteorological Committee in 1910.* With an atlas of photographs of Clouds selected from the Collection of Mr. G. A. Clarke of the Observatory, Aberdeen. (M.O. 233, 2nd edition.) Pp. 10+17 plates+5. 1*s.* 6*d.* net. *Notes on Meteorological Corrections for the use of Gunners.* By D. Brunt and J. Durward. Pp. 18. 3*d.* net. *Forecast Code for the Abbreviation of Weather Forecasts transmitted by Telegraphy or Radiography.* Pp. 18. 1*s.* net. *The New International Code for Meteorological Messages*, 1922. Pp. 20. 4*d.* net. *Weather Forecasting in the North Atlantic and Home Waters for Seamen.* By Com. L. A. Brooke-Smith. Pp. 24. 6*d.* net. *The Wireless Weather Manual.* Pp. 24. 9*d.* net. (London: H.M. Stationery Office, 1921–1922.)

ON turning over this packet of the latest official publications on meteorology I feel disposed to survey them in a contemplative rather than in a critical attitude. They fall into two groups. The Catalogue of Meteorology in the Science Museum reviews the present in the light of the past, and the various publications of the Meteorological Office of the Air Ministry deal with the present in anticipation of a greater future.

Meteorology in a museum is something of a problem, for it is impossible to place samples of weather in a glass case, or at least to keep them there when the fog clears away, and the representation can be only by instruments, maps, diagrams, and models. The collection of instruments is intended to represent historical development and present-day adaptations, and the Catalogue gives a short description of the exhibits, following a brief historical introduction on each group of instruments. The number catalogued is considerable and achieves a fair historical continuity. Their ownership is left curiously vague; some are recorded as presented to the museum, but many are stated to be lent by well-known meteorologists, most of whom are now dead, so that it is scarcely likely that their return will be demanded. We note one misprint in the name of Prof. Mohn, who is consistently called Möhn, possibly under the influence of Föhn. A reference should be given to "British Rainfall," 1908, p. 25, for the principle of the Hyetograph (No. 206), from which the originator as well as the patentee of the instrument could be ascertained.

The exhibits other than instruments are scrappy and of little value as illustrations of the scientific developments of meteorology, but time and some fostering care should remedy this.

Turning to the side of present effort which faces the future, one looks on a new world. For thirty years, from 1882, I read every contribution to meteorology published accessibly in the English language and a good deal in other tongues. For the last ten years I have read practically nothing, and now find that a vast river of new research and discovery separates me from the old familiar country where Buchan ploughed his lonely furrow and sowed the seed of upper-air research on the inhospitable summit of Ben Nevis. How wide and deep that river is I recognise when in the preface to Mr. Pick's "Short Course in Elementary Meteorology" I find the Director of the Meteorological Office saying:

"The British Empire has produced some of the world's foremost meteorologists—Halley, Beaufort, Abercromby, Blanford, Eliot and Shaw, to mention only a few."

No Buchan and no Aitken among these immortals! An oversight of a too busy man, of course, but significant of the new horizons on which the great figures of the immediate past stand out in view of the men who are reaping the harvests now maturing. It is the natural fate of pioneers to be buried in the foundations they lay for others to build on, and the fundamental nature of their work may remain unrecognised until the historians of a later generation tunnel amid the ruins of successive superstructures to find material for some science museum. Anyhow, it is certain that the enterprise of the students of to-day is put to better purpose in pushing onwards rather than in looking back. The war is responsible for the abruptness of the overturn which has buried much of the past before it is dead, and now affords to the young men an unencumbered field.

In Mr. Pick's work and Dr. Simpson's preface it is good to find strong grasp of essential principles, a discriminating disregard of irrelevant detail, and an easy command of concise and vigorous English. It would serve no purpose to regret omissions from so short a treatise on so great a subject. There is a wise abstention from the use of long words when short words serve better, and indeed the only lapse into this besetting fault of youth I have noticed is the use of the terms "katabatic" and "anabatic" with reference to the valley winds by night and day; this just serves to quicken a sense of thankfulness that we are spared "katapelagic" and "anapelagic" attacks on the land and sea breezes or even on the monsoons.

Dr. Simpson's approval can scarcely extend to Mr. Pick's statement that "no great land masses are situated in the southern" hemisphere, for is there not the Antarctic continent, very potent in its influence on the air? The effect of oceanic circulation is passed by, and I am sorry that Mr. Pick has missed the interesting analogy between the upward gradient of temperature in the atmosphere and the downward gradient of temperature in the hydrosphere. The treatment of water vapour in the atmosphere is delightfully fresh and clear; the old confusion has passed away and the student who starts his study of meteorology with this little book is led straight into the heart of the subject.

To one who remembers the astonishment and incredulity with which Dr. John Aitken's discovery of nuclear condensation was greeted, it is quaint to see Mr. Pick's fresh mind jumping the event with "It was formerly thought that dust-particles formed the nuclei for condensation but——" and after all the new discovery is only that hygroscopic particles such as common salt are the efficient nuclei. Aitken classed salt-particles as "dust," and who can say that any particles in our atmosphere are not seasoned with salt?

To me the value of this short course is the proof it conveys that meteorology has attracted the rising men of science, not as a humdrum routine, but as a fascinating pursuit confidently expected to yield rich results. Already, as the admirable section on the upper air and the brief but comprehensive account of weather forecasting show, the reward is being grasped.

Of the other publications before us, those dealing with the various codes for transmitting weather data are of interest only to the senders and receivers of telegraphic and radiographic reports, yet the mere fact that such elaborate systems of communication have become necessary shows the vastness of the recent strides in synoptic meteorology.

"The Observer's Handbook" is an old friend, inclining towards portliness now, and with an air of dignity consonant with its post-war price. The appendix of cloud-photographs by Mr. G. A. Clarke of Aberdeen, also issued separately, is helpful in defining the forms of cloud, and more so in showing how independent the clouds hold themselves of all hard and fast classifications. The prints of cirrus and allied forms showing the cloud in white on a blue ground are particularly effective.

The Handbook is ripening for complete revision and cannot yet be viewed as having reached a final form. It is still suggestive of the compiler's anxiety to justify the system of units recommended, and it remains rather over the head of the average observer, on whose faithful and patient routine the whole structure of weather study is based.

The new units which were suggested about 1908, and introduced by the Meteorological Office eight years ago, have had a less fair trial than the length of time they have been before the meteorological world suggests, as criticism on such matters was necessarily suspended during the war. I think that the substitution of the millimetre for the inch in rainfall measurement is well on its way; it is merely the substitution of one legal unit for another, and it makes for uniformity with other nations. The millibar, however, has not yet helped towards uniformity, although Commander Brooke-Smith, in his "Weather Forecasting . . . for Seamen," says that "it will help towards obtaining uniformity if new barometers are graduated with this scale." I suppose that its future will depend largely on propaganda, like a new sect inspired by the ambition of unifying all the churches. Some observers will continue to look on it as simply a new linear measure. Once a rainfall observer, wishing to be up-to-date, ordered a rain-measuring glass to be graduated in millibars so as to be directly comparable with the barometer! The idea of freeing the measurement of atmospheric pressure from the gravity correction by using a unit based on acceleration instead of weight appeals powerfully to some minds. I think, however, that it will be apt to share the fate of the kilowatt in its competition with the horse-power, *i.e.* to be limited in its use to special lines of work. Messrs. Brunt and Durward, in their "Notes on Meteorological Corrections for the use of Gunners," use the old units, apparently as a matter of course, without apology.

So far as I can see from these publications, there is now a tendency to relax the boycott of the handy old Fahrenheit degree, thereby going back to the "absolute zero" of the snow-and-salt epoch. I have sometimes yearned for a scale starting at the "absolute zero" of the mercurial thermometer, that captivating temperature at which Fahrenheit and Centigrade thermometers read alike and below which mercury refuses to work. Can we look on the "absolute zero" of the air thermometer as absolutely fixed? May a lower temperature not be reached some day and a new way of estimating it be discovered? Think of the absoluteness of the old Daltonian atom. As a mere matter of nomenclature "absolute temperature" sounds unhappy in our days, when absolute time and absolute space are on the verge of becoming unfashionable. Be that as it may, I am glad that there is now less probability than there was once of temperatures reckoned from $-273°$ C. being harnessed to our English weather.

If I may conclude in a lighter vein I would refer to a misprint in one of the works under notice printed officially. Once on a time an official of a department, driven beyond discretion by the delays of another department, addressed a letter to the "Controller of H.M. Stationary Office," and was dealt with in a disciplinary manner. Times have changed, and now a waggish printer's imp has the audacity to speak disrespectfully of the isobars in these words—"anticyclones . . . often remaining more or less stationery for several days."

Hugh Robert Mill.

The Constitution of Matter.

Der Aufbau der Materie: Drei Aufsätze über moderne Atomistik und Electronentheorie. Von Max Born. Zweite, verbesserte Auflage. Pp. vi + 86. (Berlin: J. Springer, 1922.) 3*s.*

La Constitution de la matière. Par Prof. Max Born. Traduit par H. Bellenot. (Collection de monographies scientifiques étrangères, II.) Pp. iii + 84. (Paris: A. Blanchard, 1922.) 6 francs.

THE most important part of Prof. Max Born's work is contained in the second and third of his essays, where he shows that it is possible to obtain approximate values for the heat of chemical union of the halogen elements with the alkali metals and with hydrogen from purely physical data. In collaboration with Landé he has calculated the repulsive force between the Na + and Cl − ions in rock salt, which, combined with the ordinary Coulomb attractions and repulsions between these ions, accounts for the measured compressibility, and finds that this force may be written $F=b/\delta^n$, where b and n are constants and δ is the distance between neighbouring ions of the same kind. For sodium chloride and other halogen-alkali compounds $n=9$. The law of force thus obtained is used to calculate the energy produced by the union of the ions to form the salt, which for one "Mol" is $U=545^3\sqrt{\rho/(\mu_+ + \mu_-)}$ kg. cal., where μ_+ is the atomic weight of the metal and μ_- that of the halogen. For absolute zero $U_{NaI}=158$, $U_{KI}=144$, when the ions are at rest in the position of equilibrium.

Nernst has shown that, if U is known, the chemical affinity *at any temperature* can be determined from purely physical considerations. These results can be checked by measuring the heat of solution of the salts, in solutions so dilute that dissociation is complete, and calculating the heat produced in such reactions as $NaCl+KI=NaI+KCl$. The values obtained were of the same order as those calculated by the above theory, but depend only on the *differences* between the values of U.

Another method of attacking the problem is to use Bohr's theory of atomic structure and radiation to find the work required to form ions from neutral atoms. Franck and Hertz have deduced that the energy of ionisation $I=h\nu_\infty$, where h is Planck's constant and ν_∞ is the limit of the series of absorption spectrum lines of the quiescent vapour. These workers have confirmed this theory by measuring the ionising potential which must be applied to a stream of electrons to produce a velocity just capable of ionising the vapour. They have thus found the energy of ionisation of a number of substances. Combining these values with values of the affinity for electrons of electro-negative atoms obtained by Franck, who used a method also based on Bohr's theory of the spectrum, the values of U can be calculated independently, and are within 12 per cent. of those obtained from the compressibility data.

Habers has studied metal crystals, on the assumption that the negative atoms in the Bragg space lattice are replaced by electrons. He finds for the alkali metals $n=2{\cdot}5$ to $3{\cdot}4$, copper $n=8{\cdot}0$, silver $n=9{\cdot}0$, in the expression for the repulsion. The heats of vaporisation calculated from these figures agree remarkably well with the observed values. The value of n must depend upon the distribution of the electrons in the ion.

The author seems perfectly justified in concluding his work in the following words: "If we survey the road we have travelled we see that, although it has not yet penetrated very far into the mighty kingdom of chemistry, it has reached a point from which we can observe, in the distance, the passes over which we shall have to travel if we wish to subject this kingdom to physical law."

Bauxite in Ayrshire.

Memoirs of the Geological Survey, Scotland. The Ayrshire Bauxitic Clay. By G. V. Wilson. Pp. vi+28. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1922.) 1*s*. 6*d*. net.

WHILE deposits of bauxite, that is, of the aluminium hydroxides gibbsite and diaspore, are greatly in request as sources of aluminium, bauxitic clays are also of considerable value for the lining of high-temperature furnaces. It is well known that under tropical conditions of weathering, especially where the surface-waters are alkaline, rocks of very varied nature, containing aluminium silicates, yield bauxite rather than kaolin. Any ferruginous matter forms at the same time lateritic crusts. Laterite, indeed, as Sir Thomas Holland pointed out for India, is at times rich in aluminium hydroxide.

Bauxitic formations have thus come to be regarded as indications of climate in the past, and we now have the interesting discovery of bauxitic clays in strata of Millstone Grit age in Ayrshire. The lateritic nature of these Carboniferous beds was pointed out by Mr. John Smith in the Transactions of the Geological Society of Glasgow in 1893. The Geological Survey of Scotland, when recently remapping the area, collected samples for analysis and proved the presence of aluminium hydroxide. Mr. Wilson, in the memoir now published, defines a bauxitic clay (p. 6) as one that "contains more alumina than is necessary to supply the demands of the whole of the silica present for the formation of the kaolinite molecule." Silica present in the form of quartz sand is included in this definition, since such silica affects the value of a clay as a refractory material.

On p. 25 twelve analyses are given of the Ayrshire bauxitic clays. The most striking of these is that of the bed on the Saltcoats shore, which yields 47·57 per cent. of alumina and only 29·0 per cent. of silica. Titanium dioxide, a substance characteristically present, amounts, however, to 9·04 per cent., and the refractory quality of a kaolinite clay is said to be lowered by 5 per cent. and upwards. This effect is not so noticeable in clays with an excess of alumina. In the Ayrshire deposits, a large part of the material of inferior grade reaches a refractory quality of 30-31 on the Seger cone scale, while the Saltcoats shore material, despite its titanium-content, is recorded as over 35.

These bauxitic clays have been derived from basaltic lavas in the first instance, though in some cases the material has been transported. It is held that kaolinite was formed as the earliest product, and that a fairly pure aluminium hydroxide arose from this, sometimes with an oolitic structure. A recombination of the silica set free occurred in some cases, a secondary kaolinite being formed. This association of kaolinite and bauxitic matter in the same series of deposits recalls observations made by the Geological Survey of Ireland on the Cainozoic beds of Co. Antrim (Mem. on the Interbasaltic Rocks, p. 51, 1912). In both areas, titanium dioxide is a prominent constituent of the clays; Mr. Wilson (p. 12) shows that it is present as rutile and anatase, less commonly as brookite, and sometimes in combination in sphene. He traces its origin to the augite of the basalts; in Ireland it has been attributed to the decay of ilmenite.

The new industry now developed in Ayrshire, in the manufacture both of refractory bricks and of alum, is a satisfactory result of the official researches here described. G. A. J. C.

Anderson Stuart: his Relation to Medicine and to the Empire.

Anderson Stuart, M.D., Physiologist, Teacher, Builder, Organiser, Citizen. By William Epps. Pp. xv + 177. (Sydney, N.S.W.: Angus and Robertson, Ltd., 1922.)

THE career of Sir Thomas Peter Anderson Stuart has few parallels in medical or other annals. His student career in Edinburgh under Turner, Rutherford, and Lister was brilliant; his building and organisation of the Sydney school, and what they provoked, form a university romance of the first order. Dean for thirty-six years, he dominated medical history in Australia in a manner that few, if any, individuals will ever be able to imitate. During that period the number of students in medicine increased from four to nearly one thousand; and for this apotheosis of his department Anderson Stuart planned and built. Without any demerit to the brilliance of assistants in his faculty or to the capacity of men in other faculties of the University of Sydney, it is no exaggeration to state that that phenomenon was the offspring of Anderson Stuart's imagination and the fruition of his consummate scheming and effective individual manœuvre.

In this sphere his work was monumental. The standards set by Anderson Stuart in his school involved the emergence of such a university in Sydney as stands to-day—not merely a local inspiration, but the most prominent centre of Anglo-Saxon culture in the Southern Hemisphere. This achievement carries Stuart's work beyond the confines of institutional endeavour, and places it in the rank of empire-building.

For Australia, his work had a distinctive result in society-moulding, in that it was the initial step towards the quasi-aristocratic rank which the medical profession now enjoys in that country, and in that it foreshadowed and conditioned the elevated professional status which dentistry, veterinary medicine, nursing, midwifery, and massage are rapidly assuming in that continent.

Such are the more outstanding facts upon which Stuart's claims to remembrance will rest. As a physiologist and a man of science he was not distinguished, nor even as a teacher. Although he was a forceful lecturer, his words were selected for their rhetorical effect, and his lecture material was that of an earlier generation of physiologists. A claim to teaching ability must rest on more than rhetoric—it must rest upon the capacity to arouse the hearers to be *doers*; and doers in physiology as a result of Anderson Stuart's teaching are difficult to discover.

To present a man's autobiography with the force, frankness, and vividness that Mr. Epps has done, vindicates his claim that it was "a labour of love." He has carried out with nice selection a difficult piece of composition, which will always bring credit to himself and to the long list of subscribers. But Epps is not a Strachey. Although he has described many of Anderson Stuart's characteristics in the introduction, and although others crop out in the faithful narrative of events, the fearless character sketch is still unpenned. The achievement of a man is only explicable in terms of his character, and can be appreciated best when the record is frankest. Such incidents as the expectation of his name at the "top of the class list," and such self-appreciation as his own declaration that "I had the essentials of a good teacher born in me," reveal the character of Stuart more warmly and nakedly. A towering ambition and a Napoleonic will to tyrannic power, together with sufficient selfishness for the realisation of these twain—these very qualities are at one and the same time the key to his achievements, to the oppositions they evoked, and to the relentless manner of their crushing.

Anderson Stuart will always stand as a beacon-light and a landmark in the history of a university and a country which have a long future.

RAYMOND A. DART.

Our Bookshelf.

The Home of the Indo-Europeans. By Prof. H. H. Bender. Pp. 58. (Princeton: Princeton University Press; London: Oxford University Press, 1922.) 4*s.* 6*d.* net.

THE original home of the Indo-Europeans is a well-worn subject, and Prof. Bender has treated it generally on the lines of philology, familiar to readers of works like Schrader's "Prehistoric Antiquities of the Aryan Peoples." He suggests, but does not grapple with, the question whether there was an Indo-European race, or merely an aggregate of tribes, possibly of varied physical characteristics, more or less closely united by a common tongue and a common culture. Anthropology and archæology may in time throw light, he suggests, on their habitat in the Stone Age, "although it will always be difficult to determine from the examination of a skull or a stone axe what language their owner spoke in life." Again, we have only grave furniture to guide us, and the consideration of broad or long skulls is of little help, because the cephalic index "is merely a ratio," and "among the living Chinese or in the Neolithic graves of Europe long skulls are nearly always found with short skulls, and *vice versa*."

Environment, again, affects the cephalic index, and the Scandinavians, supposed by some authorities to represent the primitive Indo-European type, "owe their long heads, not alone to race, but partially, at least, to hyperthyroidism and ultimately to the iodine of the seas near which they have lived, and from which they have obtained a considerable part of their food." The most novel point raised is that of the newly discovered Tocharian language in East Turkestan, a *centum* language, possibly introduced from the west, the home of languages of this type. Mainly on the evidence of philology the author reaches the conclusion, held by many scholars, that the primitive home of the Indo-Europeans was the great plain of Central and South-Eastern Europe, including the present Poland, Lithuania, Ukraine, and Russia south and west of the Volga. There is not much original matter in this little book, but the points are well put, and it will be useful as a guide to the study of a problem which has not yet been finally settled.

The Journal of the Institute of Metals. Vol. 27. Edited by G. Shaw Scott. Pp. viii + 621. (London: The Institute of Metals, 1922.) 31*s.* 6*d.* net.

THE increase of research in non-ferrous metallurgy is so rapid that succeeding volumes of the Journal of the Institute of Metals show a rapid growth in size. Volume 27 contains some interesting papers on recrystallisation and grain growth. The paper by Mr. Adcock, containing a beautiful series of photographs illustrating recrystallisation in cupro-nickel, an alloy which proves very suitable for the purpose of this study, will be of material assistance in advancing the subject, which has been studied with such good results by Carpenter and Elam. Major Smithells' paper on grain growth in tungsten filaments makes use of the hypothesis of varying vapour pressure. Condenser tubes are considered from two points of view, the experience of the Corrosion Committee being utilised as a basis for recommendations as to their care in practice, while a second paper from the Research Department at Woolwich deals with the prevention of season cracking by the simple process of removing stress by low temperature annealing. The revision of the alloys of aluminium and zinc clears up some difficult points in the behaviour of this curious system, one of the most interesting in respect of its changes in concentration of solid solution with temperature. Several other papers deal with questions of practical importance, and the volume contains a very large number of abstracts of work published elsewhere.

Arab Medicine and Surgery: A Study of the Healing Art in Algeria. By M. W. Hilton-Simpson. Pp. viii + 96 + 8 plates. (London: Oxford University Press, 1922.) 10*s.* 6*d.* net.

IN this volume Mr. Hilton-Simpson describes the medical and surgical methods of the Shawía of the Aurès Massif of Algeria. His record is the result of careful inquiry pursued in the course of a number of visits to the country, and possesses a peculiar value in that it deals with practices which must inevitably disappear before the advance of civilisation. Although some of the treatment prescribed by Shawía medicine is derived "from the sorcerer's defensive armour against Jenun," the demons or spirits which cause disease, medical practice is not here synonymous with magic, as among most primitive peoples. The medical practitioner is regularly apprenticed, usually to a member of his own family. The medical treatment would appear to be derived from the medicine of the medieval Arabs. The origin of their surgery is more obscure, and it has been suggested, on account of the primitive character of their instruments and the prevalence of the operation for trepanning, in which they take much pride and show much skill, that it may possibly go back so far as the Neolithic age. The trepanning operation is usually successful, a fact which is due perhaps as much to the remarkable vitality of the people as to the skill of the surgeon.

A Naturalist's Calendar, kept at Swaffham Bulbeck, Cambridgeshire. By L. Blomefield. Second edition, edited by Sir Francis Darwin. Pp. xviii + 84. (Cambridge: At the University Press, 1922.) 3*s.* 6*d.* net.

THE Cambridge University Press was well advised in adopting Sir Francis Darwin's suggestion to republish this Calendar. Lists such as those compiled by Blomefield not only assist the amateur naturalist, but are of real value as contributions to the science of phenology. A collection of such Calendars embodying the notes of some of the scores of observers scattered over the British Isles, and based on a consecutive series of years, would probably add not a little, in the hands of a central receiver, to our knowledge of the movements of birds, the awakening of vegetation, and other phenomena dependent upon the seasons.

Woodland Creatures: Being some Wild Life Studies. By Frances Pitt. Pp. 255. (London: G. Allen and Unwin, Ltd., 1922.) 12*s.* 6*d.* net.

"STUDY any animal, even the most common, carefully, and you will find out something that has hitherto escaped notice." Repeatedly did this sentence spring to mind as we read the pages of this charmingly written and beautifully illustrated book. The author, whether writing of the furred or the feathered creatures of our woodlands—of badgers, foxes, dormice, rabbits and squirrels, or of woodpecker, bullfinch, kestrel, sparrowhawk, owl, magpie and jay,—tells us something of habits or of adaptation of structure to habit that we have not met elsewhere; and not infrequently has shrewd criticism to offer on plausible theories of armchair origin. Her photographic illustrations bear comparison with the very best.

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.*]

Palæontology and Archaic Fishes.

It is now a good many years since I first decided to devote myself to the study of vertebrate morphology. I was attracted to this study through feeling in the old days at Cambridge that the position of comparative neglect into which this science had fallen was the fault, not of the subject itself, but rather of that band of enthusiasts who, carried away by the inspiration of Darwin, and setting to work at the building of the new morphology, took in their haste but little heed that the foundations upon which they built were adequate either in extent or in sound workmanship. As regards the former, an important gap in the foundations was glaringly visible in the region occupied by these two exceedingly archaic subdivisions of the Vertebrata—the Crossopterygii and the Dipnoi. In particular, nothing whatever was known regarding the early developmental stages of any crossopterygian or of either of the two lung-fish which seemed nearest to the evolutionary stem of the terrestrial vertebrates. It was the recognition of the importance of this gap in the foundations of vertebrate morphology that, above all, influenced me in taking the decision to do what I could towards making the gap less extensive. Seeing that so much of my research work has been concerned with the two groups I have indicated, I may perhaps be regarded as justified in having a special interest in them and their relation to the general problems of vertebrate morphology.

I am in consequence particularly interested to find in the newly published Proceedings of the Linnean Society the presidential address of Dr. Smith Woodward entitled " Observations on Crossopterygian and Arthrodiran Fishes." In view of the president's position as the official head of British palæontology, and still more in view of his pre-eminent position as an investigator of the palæontology of the lower vertebrates, his words will carry great weight where he is dealing with palæontological fact. In the course of his address, however, he comes into touch with some of the broader questions of vertebrate morphology, the answers to which, if they are to be trustworthy, must necessarily be based upon the judicial consideration of all the evidence available, and not merely of that which is constituted by the data regarding skeletal structure afforded by palæontology. It is, I think, particularly necessary to remind the younger generation of workers, to whom will fall the task of restoring morphology to its proper position in biological science, that as regards several of the questions dealt with by Dr. Smith Woodward, due heed must be given to witnesses other than palæontological.

It would not, for example, be gathered from the address in question that we do not all accept Dollo's view that the modern lung-fish have " abandoned the fusiform shape which is adapted for free-swimming life, and have become (secondarily) more or less eel-shaped in adaptation to a wriggling and grovelling existence."

There is no general characteristic of the Vertebrata more fundamental than the fact that during early stages in their development their muscular system consists of segmentally arranged blocks of longitudinally-running fibres along each side of the body. There is no escape from the physiological implication that this peculiar arrangement of the muscular system has for its function the production of movements of lateral flexure. To some of us, the further conclusion appears to be equally inevitable that the vertebrates in general were in early stages of their evolution " more or less eel-shaped in adaptation to a wriggling and grovelling existence."

The view may of course be held that, even admitting that the primitive vertebrates were elongated in form, yet the ancestors of existing Dipnoi were, for a time during their evolutionary history, fusiform —just as was undoubtedly the case with the ancestors of the eel-shaped teleostean fishes.

Whichever view is taken as to the fusiform ancestral stage of the Dipnoi—whether primitive or merely intercalated—I regard the evidence in the way of known facts as quite inadequate to form the basis of any such idea. This evidence is palæontological in its nature. Stated shortly and crudely, it is constituted by the fact that the palæozoic dipnoans with which we are acquainted up to the present are on the whole fusiform, while the modern dipnoans are elongated in form.

Personally, I take the view that the vertebrates, during the prolonged early phases of their evolutionary history before they evolved into creatures highly specialised, on one hand, for a purely swimming habit—like the modern fish—or, on the other, for a terrestrial existence as are the modern tetrapods, were actually, in all probability, creatures of elongated form of body which " wriggled and grovelled " in a swampy environment. Further, I believe that such conditions are highly unfavourable (1) to existence in crowds or shoals, and (2) to that rapid enclosure in preservative silt or other deposit which is essential to their persistence as fossils. Consequently I should attach very little weight to the fact that the specimens known to us as fossils of the palæozoic dipnoans happen to have fusiform bodies. As a matter of fact, I regard the fusiform body just as I regard the divided-up median fin and the heterocercal tail (or its further development the homocercal tail), as marks of the efficient swimmer. They are characteristics which I should expect to find in the majority of species in any group of fish during its period of maximum prosperity, when it reached the highest degree of adaptation to a purely swimming existence.

Dr. Smith Woodward mentions the failure up to the present to discover fossil links between the paired fin of the crossopterygian and the leg of the terrestrial vertebrate. I suppose I am still in the position of being the only investigator of the evolutionary history of the vertebrate limb who has had at his disposal embryological material of Polypterus and of all the three genera of lung-fish in addition to that of elasmobranchs and amphibians. It may be well, then, to state that my own work, together with a careful consideration of the work of others, palæontologists, anatomists, and embryologists, leaves no doubt in my mind that the reasonable view to take is that which regards the paired fin (of whatever type—archipterygial, crossopterygial, or actinopterygial) on one hand, and the pentadactyle leg on the other, as being limbs specialised for different types of movement, neither of which has evolved out of the other, but each of which has evolved out of an ancestral, more or less styliform, type of limb.

There is another point to which it seems desirable to refer, namely, the use of group names based on our knowledge of existing animals in discussions on palæontology. The natural classification of animals is of course a concise method of summing up their morphology, *i.e.* their genetic relationships as expressed by their structure. In working out these relationships, as every morphologist knows, it is essential to have due regard to structure as a whole, collecting and weighing the evidence afforded by all the various organ systems of the body. The group name Dipnoi, or Amphibia, or Reptilia, or Aves, or Mammalia, connotes in each case a particular assemblage of structural characteristics relating to the entire structure of the body.

Now it is particularly desirable to bear in mind that when an extinct animal is allocated to one of the larger classificatory groups, this is done as a rule on no more sure basis than a knowledge—often a very imperfect knowledge—of the inorganic portions of its skeletal system, and consequently such allocation is, as regards the probability of its being correct, on a totally different footing from the assignment of a modern animal to its taxonomic group after full consideration of its whole structure. It is quite impossible for any one to say whether a palæozoic creature now included in the group Dipnoi or Crossopterygii would, or would not, have this inclusion justified were we acquainted with its general structure apart from the skeleton. The same consideration indicates to us how vain were the old controversies as to whether the ancestor of the group Mammalia was an amphibian or a reptile. Even had we before us the undoubted skeleton of that ancestor in perfect condition, we should still require to know about its soft parts—its skin, its heart, its main blood vessels, its brain, its urinogenital organs, its embryonic membranes, and so on—before we should be justified in concluding definitely in which, if either, of the two groups named it should really be included.

J. GRAHAM KERR.

The University, Glasgow, December 19.

Some Interesting Tracks of Alpha Particles in Gases.

SELECTED photographs taken from about ten thousand exposures show a number of types of alpha ray tracks, some of which have been described before and some have not. Fig. 1 gives a track in which

FIG. 1.

it is apparent that the alpha particle hits the nucleus of an oxygen or nitrogen atom. The nucleus is projected forward at a very high speed, while the alpha particle is reflected backward at a sharp angle. In Fig. 2 the track is an almost straight line with a branch which goes off at an angle of about 8°. In some instances the branch is at an angle as great as 50° with the straight track. An example of this is given in Fig. 3, though in the plane of the photograph the angle is only 40°. In some instances another type of track is given, in which one of the

FIG. 2.

branches is very short, the other very long. It is not unlikely that some of the longest tracks are due to hydrogen nuclei. A discussion of the tracks will be published very soon in one of the physical journals. All the photographs were taken by the Shimizu-

FIG. 3.

Wilson method, by means of which many more photographs showing views at right angles will soon be taken.

R. W. RYAN.
W. D. HARKINS.

University of Chicago,
December 23.

The Age and Area Hypothesis.

IN a paper by the late Prof. D. P. Penhallow, of McGill University, Montreal, entitled "A Review of Canadian Botany from the First Settlement of New France to the Nineteenth Century, Part I." (Proceedings and Transactions of the Royal Society of Canada for 1887, volume 5, section 4, pp. 45-61, 1888), the following passage occurs:

"But Michaux appears to have attached a much wider importance to his prospective work, and to have regarded it more from a scientific point of view, since he had already conceived the idea that the distribution of the trees of America should be studied, and that it would be possible to ascertain their original centres of distribution through careful observation of their dimensions and predominance in different parts of the country. It was the elaboration of this idea that largely led him in so many directions, and over so wide a range of territory" (D. P. Penhallow, Proc. and Trans. Roy. Soc. Can., 1887, 5, sect. 4, pp. 55-56, 1888).

Apparently Michaux was of the same way of thinking in reference to the Origin of Species as Dr. Willis. J. ADAMS.

Central Experimental Farm,
Ottawa, December 18.

THIS reference is of great interest. As I have shown in the Introduction to my recent book upon "Age and Area," both Lyell and Hooker had conceived the ideas which I have elaborated. The incoming of the Darwinian theory of evolution, however, with its novel conception of universal gradual change, diverted effort from the lines that it was beginning to follow, and to which it shows signs of returning, with the increasing recognition of the fact that gradual change is not possible in the case of most characters. JOHN C. WILLIS.

Zoological Nomenclature: Musca and Calliphora.

IN accordance with the rules of the International Zoological Congress, the attention of the zoological profession is invited to the fact that Dr. L. O. Howard, W. Dwight Pierce, and twenty-one other professional zoologists have requested the International Commission on Zoological Nomenclature to exercise its plenary power in the case of the Linnæan genus Musca, 1758, and, under suspension of the rules, to declare *M. domestica* as type of this genus; also, under suspension of the rules, to validate Calliphora, Desvoidy, 1830, with *C. vomitoria* as type.

The request is based on the grounds of practical utility, and an almost unbroken history of consistent usage since 1758 in the case of Musca, and since 1830 in the case of Calliphora. It is claimed that a strict application of the rules will produce greater confusion than uniformity.

According to the premises at present before the Commission, if the rules are strictly applied, the generic name of Musca would take either *M. cæsar* or *M. vomitoria* as type, and the species *M. domestica* would be cited either in Conostoma, 1801 [?] (type *Ascaris conostoma* = larva of *M. domestica*), or in Conosoma, 1802 (type *Ascaris conosoma* = larva of *M. domestica*), or in Promusca, 1915 (type *M. domestica*), thus resulting in a very regrettable change in the nomenclature of the species in question as almost universally used in entomological, zoological, medical, epidemiological, and veterinary literature.

The secretary of the Commission invites any person interested in these cases of nomenclature to communicate his opinion on the subject as soon as possible. On account of delay caused by the war, the final vote of the Commission will not be taken until about January 1, 1924. C. W. STILES
(Secretary to Commission).

25th and E Streets, N.W.
Washington, D.C.

Tesla Spectra and the Fraunhofer Effect in Complex Compounds.

IN conjunction with Mr. W. H. McVicker, we have begun an investigation of the spectra emitted by the vapours of compounds when subjected to waves from a Tesla transformer passing between two glass-coated electrodes. For the sake of clarity, these spectra may be termed electro-luminescence spectra.

Among the substances examined by us was benzene. At ordinary pressure and at the boiling-point, the vapour of benzene emits only a fragmentary spectrum which seems to be built up from portions of the carbon spectrum, only the strongest bands making their appearance. On reducing the pressure of the vapour, an extremely regular spectrum is emitted by benzene; a very regular set of band-groups, each of which has the same general internal structure as the others. Six of these band-groups lie between $\nu=3104$ and $\nu=3752$; while traces of yet another band-group were observed in the region beyond 3194. Beyond 3765, the absorptive power of the vapour itself cuts off part of what is evidently another set of band-groups.

Each of the band-groups has the following structure: four strong bands, each accompanied by a weaker band; then two broader and weaker bands, which may possibly be produced by the fusion of the strong and weak companions of a doublet.

The whole spectrum shows an extraordinary regularity. There are no air-lines or spark spectra traceable throughout its extent; nor are there any lines visible on the parts of the plate unaffected by the luminescence spectrum. The following figures represent the wave-numbers of the four strong bands in each group:

Group	A.	B.	C.	D.	E.*	F*.
	3752	3652	3554	3454	3357	3257
	3736	3636	3537	3438	3339	3242
	3717	3618	3521	3422	3322	3229
	3703	3602	3504	3405	3308	3211

For the band-groups marked with an asterisk, the readings on the plate were difficult—the bands being diffuse—and the figures are probably not exact.

The whole of the bands in the electro-luminescence spectrum appear to be directly related to each other; their wave-numbers are calculable from the following formula:

$$\nu = 98 \cdot 712n - \frac{98 \cdot 712m}{6},$$

where n is successively equal to 33, 34, 35 . . . and m is successively 0, 1, 2. . . .

The electro-luminescence spectrum presents especial interest when it is compared with the fluorescence and absorption spectra of benzene. Hartley (Phil. Trans., 1908, 208, 510) and Grebe (*Zeit. wiss. Phot.*, 1905, 3, 363) found that the change from benzene vapour to a solution of benzene in alcohol produced a shift of 10-20 units in the position of the absorption bands towards the less refrangible rays. If the same shift be assumed to occur in the case of fluorescence, then it appears that the full fluorescence spectrum of benzene corresponds, band for band, with a part of the luminescence spectrum, as the following figures show:

Electro-luminescence bands . .	$\nu=3454$	3554	3652	3752
Fluorescence bands . . .	$\nu+19=3454$	3556	3650	3752

An even more surprising result is obtained by comparing the electro-luminescence and absorption spectra of benzene vapour. Hartley (*loc. cit.* 484) divides the absorption bands into four series. When his least refrangible bands are compared with our most refrangible set, the coincidence between the two is most remarkable. For the sake of brevity, only the first strong series is given here:

Absorption bands .	=3650	3683	3700	3716	3734	3719-52	3761
Luminescence bands .	=3652	3686	3703	3717	3736	3752	3765

Thus, if an obvious constant difference of 2 units between our scale-readings and those of Hartley be assumed, all these bands coincide within our experimental error.

This appears to establish that parts at least of the benzene absorption spectrum are replaced by luminous bands in the electro-luminescence emission spectrum, just as the dark Fraunhofer sodium line in the solar spectrum corresponds to the D-line in the emission spectrum of sodium. In other words, *the Fraunhofer effect has now been established in the case of the spectrum of an organic compound of complex structure.*

A more detailed account of this work will be published almost immediately. We wish to reserve this particular group of spectra for our own investigation, as we have already planned and in part carried out a connected series of investigations upon it, which we wish to complete before venturing upon the theory of the matter. We hope also to investigate the behaviour of solutions under the influence of the Tesla discharge.

J. K. MARSH.
A. W. STEWART.

The Sir Donald Currie Laboratories,
The Queen's University of Belfast,
January 8.

Distribution of the Organ-Pipe Diatom (*Bacillaria paradoxa*).

IN connexion with the interesting question raised by Mr. F. Chapman in NATURE of January 6, p. 15, as to the peculiar movements of *Bacillaria paradoxa* being due to osmotic pressure, I am writing to say that all the specimens observed by Mr. H. Weaver and myself that were gathered from the Staffordshire and Worcestershire Canal at Stourport and from ponds at Wilden and Hartlebury (see NATURE, vol. 108, p. 163) were very active and so continued during the period we kept them under observation (about a week in each case). The water in this canal and in these ponds is some eighty miles removed from the sea. It is quite fresh and not at all brackish.

J. W. WILLIAMS.

67 Load Street, Bewdley, Worcs.

Experiments on Hardness and Penetration.

As a student of colloidal chemistry I was much interested in the results of the experiments on the clay-water systems by Mr. A. S. E. Ackermann (NATURE, January 6, p. 17), showing that there was a continuous penetration of the systems by a heavy object when its pressure exceeded a certain critical value referred to as the "pressure of fluidity."

The phenomenon has been observed in many colloidal systems and also with the coarser systems such as paints, thick oils, etc. Bingham found zero fluidity or infinite viscosity with 4 per cent. china clay or 5·5 per cent. of graphite. E. Hatschek, investigating aqueous solutions of gelatine, showed that the viscosity varied with the rate of shear, and a similar conclusion was reached by Hatschek and Humphrey, working with systems of sifted rice particles in toluene-carbon tetrachloride. In general, at the lower rates of shear the viscosity is abnormally high and even infinite if the system be coarse-textured.

With the Stormer type of viscometer the curve relating the number of revolutions per minute of the cylinder rotating in a coarse system such as a paint or grease, with the load rotating it, is curvilinear and does not pass through the origin.

The minimum load required to start rotation, apart from that to overcome the friction of the apparatus, would correspond to the "yield point" obtained by the use of Bingham and Green's plastometer, or the "pressure of fluidity" by Mr. Ackermann.

It is evident that the viscosity of these systems has lost its usual significance since it is a variable function and any value obtained by any one method is empirical. This would apply to the value given by Mr. Ackermann for the viscosity of lead in the solid state.

Another interesting phenomenon in this connexion is that the rate of penetration by the object gradually decreases and eventually ceases; thus a steel ball remains suspended in a well-mixed paint after a fall of some distance. With some oils, a falling sphere cuts a path through the liquid, so that the apparent viscosity decreases with each determination by the falling sphere method.

E. MARDLES.

2 Hillfield Villas, Union Street,
Farnborough, January 9.

IT is with great interest that I read Mr. Ackermann's letter in NATURE of January 6, p. 17, with regard to the penetration of clay and lead by a loaded disc. The manuscript of a paper intended for the next meeting of the Iron and Steel Institute is now complete. The work deals with several of the deductions to be made from my formula for Brinell hardness (NATURE, December 9, vol. 110, p. 773).

While clay has not been examined, tests have been carried out on pitch and plasticine. Meyer's formula appears to be true for these two materials.

HUGH O'NEILL.

The Victoria University of Manchester,
January 9.

A New Gregarine Parasite of Leptoplana.

MR. SAM SETNA, who is working under my supervision on the Polycystid Gregarines, has just found specimens of a Cephaline Gregarine infesting a specimen of *Leptoplana sp.* recently obtained from the Marine Biological Laboratory at Plymouth. This Gregarine seems to be rather a rare parasite of Leptoplana, as no Gregarine has been described before from Leptoplana, according to lists given by Minchin (1903) and Watson (1916), or in literature published since. Indeed, extraordinarily few Sporozoa have been found from the Platyhelminthes as a whole. The find is all the more remarkable as Leptoplana is so commonly used as a type animal. Only a single specimen was found to be infected, and other specimens in the same tube that have been examined do not show the infection.

In the sections of the infected worm, a number of individuals of the Gregarine have been found in the parenchyma of its body. The trophozoite is solitary and quite large in size, measuring from 103 μ to 168 μ in length. The protomerite is quite distinctly marked off from the deutomerite. Only one young individual has been found showing the epimerite. The latter is large, hemispherical, and simple. The nucleus is large and rounded and measures 19 μ to 23 μ in diameter, and exhibits the characteristic Gregarine structure, with a slightly eccentrically placed karyosome and a number of chromatin particles disposed round it.

Unfortunately, no other stages of the life-history have been encountered, and it is consequently impossible to refer the parasite to any particular genus.

B. L. BHATIA.

Zoological Laboratory.
Government College, Lahore,
November 23.

Discovery of the Use of Phosphates as Fertilisers.

IN view of the interest attaching to the so-called artificial fertilisers, it may be worth recording that the idea of the possibility of utilising raw mineral phosphates as phosphatic fertiliser is to be found in the current agricultural publications some years before 1840, the date usually regarded as that of the first serious record.

In 1842 Lawes took out his patent for the manufacture of superphosphate. In a question of infringement that arose later he showed that his application for a patent was the result of work at Rothamsted with bones and mineral phosphates from 1839, and with bone dust from 1843. Liebig had suggested phosphatic manure in a report to the British Association in 1840.

But in May 1837 an unnamed correspondent of the *Farmers' Magazine* (2nd series), writing on the difficulty and expense of obtaining bone dust in the required quantities, proposed the making of a "fictitious bone dust by impregnating lime with phosphoric acid." Another correspondent in answer asserted (May 1837) that there was no cheaper way of getting phosphorus than by burning bones, adding, however, "phosphate of lime if it could be found so as to be available to the farmer, would be invaluable. Whether it exists in England I know not, but in Spain there are entire mountains of it; it is compounded of phosphoric acid 41 parts, lime 59"; showing an earlier appreciation in England of the fertilising possibilities of Spanish phosphorites than is generally realised.

Whether or not Lawes had read these letters we do not know, but they form an interesting foreshadowing of the great work he began two years later.

E. J. Russell.
A. Henderson Smith.
Rothamsted Expt. Station,
Harpenden.

Soil Reaction, Water Snails, and Liver Flukes.

May I be allowed to add a few words to the discussion on *Limnæa peregra* and the liver rot of sheep, etc. First with regard to outbreaks of the disease following the application of lime. During a considerable experience of Mid and North Wales I have had a number of such cases brought to my notice by farmers (in one case basic slag had been used). In all cases the dressings had been applied to rough wet pastures of the "sour" type, which are not grazed closely by stock. In parts of these fields *L. truncatula* was present, but, owing to light grazing of the abundant herbage, the encysted cercariæ had presumably not been ingested. Following an application of lime, a "sweetening" or improvement of the pasturage leads to closer grazing and a more or less intense infection of the stock. This, at any rate, is my opinion following the investigation of actual cases.

Secondly, as to the distribution of the two species of Limnæa (in the same regions). Both are abundant, and although they may occur together now and again, it is usual for *L. peregra* to frequent the softer muds and *L. truncatula* the firmer substrata. For example, if a small streamlet be followed, *truncatula* will often be found in its upper and *peregra* in its lower (and more muddy) portions. In a wide ditch, *truncatula* may occupy the margins and *peregra* the soft central portion. These habitat differences are probably due to the relative size and expanse of foot. While working on the bionomics of *truncatula* I made some notes on *peregra* also; these were incorporated in a paper published in *Parasitology*, x., No. 2, December 1917.

With regard to *peregra* acting as an intermediate host for *Fasciola hepatica*, I have on several occasions obtained cercariæ from that species which I cannot distinguish from that of *F. hepatica* (*Cercaria fasciolæ hepaticæ*, Thomas). This, however, is not a common occurrence in my experience, although I have examined numerous samples of *peregra*. The last two cases were (*a*) from ill-drained fields, near Llanwnda, Carnarvonshire, elevation about 100 feet; (*b*) on the mountains near Bethesda, elevation more than 1000 feet. In both instances liver rot had occurred. In the first *truncatula* was present also; in the second only *peregra* could be found.

C. L. Walton.
Department of Agriculture,
University College of North Wales,
Bangor, January 15.

The Silent Zone in Explosion Sound-Areas.

In the recent interesting article on the Oldebroek explosion, it is stated (Nature, January 6, p. 33) that in no case has it been found that the nearer margin of the outer sound-area lies at so short a distance as 114 km. from the source. When the minute-guns were fired at Spithead during Queen Victoria's funeral procession on February 1, 1901, there was a clearly marked silent zone, and the nearest point of the outer sound-area was 80 km. from the flagship. In this case the sounds were easily recognised, as they recurred at regular intervals (*Knowledge*, vol. 24, 1901, pp. 124-25; *Science Progress*, vol. 14, 1920, pp. 625-26). In the sound-area of one of the Asama-yama explosions (December 25, 1910) the corresponding distance was about 87 km. (Bull. Imp. Earthq. Inves. Com., vol. 6, 1912, pp. 61-63 and plate 18). These figures have an important bearing on the origin of the silent zone.

C. Davison
70 Cavendish Avenue, Cambridge,
January 12.

Time Relations in a Dream.

It is commonly believed that a dream which appears to be of long duration lasts in reality for a short time only. Since precise knowledge on the point is difficult to get, the following observations may be of interest. Having fallen asleep again, after being called a few mornings ago, I dreamt I was visiting a strange laboratory. On entering I was aware of a deafening hammering noise which rendered conversation impossible. My host took me to another room, where the noise was inaudible, but on returning to the first room it continued, the blows being at about the same interval. I then noticed, what I had not seen before, some one striking a pipe in a shaft in the wall, but I reflected that the force used seemed quite insufficient to produce the sound heard.

On awaking suddenly I connected the sound with the chipping of a stone-mason at work on the war memorial across the road. Remembering Mr. J. Barcroft's letter to Nature (1919, vol. 104, p. 154), I timed the chipping blows. They were from 26-34 por 10 seconds, averaging 3 per second. Going over the dream it seemed that the loud sounding blows, which produced a continuous reverberation, were about 15 or 16 per 10 seconds; thus the time in the dream proceeded at about—or possibly slightly less than—twice the normal rate.

Both before and after the cessation in the dream —corresponding probably to one of the mason's pauses —the rate was the same. In this respect the experience differs from Dr. Barcroft's, for his clock ticking four to the second appeared to give a five-second interval, namely a twentyfold exaggeration; this, later in the dream, was reduced to a fourfold exaggeration. The noise of which I was conscious in the dream appeared to go on before the interval for about a minute and after it for two or three, with about a minute between. The duration of the dream appears accordingly to have been about two minutes or slightly longer. The loudness of the noise, as it was experienced in the dream, is remarkable in view of the actual loudness. The note was also far more metallic.

W. R. G. Atkins.
Marine Biological Laboratory, Plymouth,
January 10.

The Disappearing Gap in the Spectrum.[1]

By Prof. O. W. RICHARDSON, F.R.S.

I.

THE Royal Institution seems a peculiarly fit place to deliver lectures on this subject, because it was while he was professor here 120 years ago that Thomas Young, the great advocate of the wave theory of light, showed how to estimate the wave-lengths of the different parts of the spectrum, and by so doing laid the foundations of spectroscopy as a quantitative science. His determinations of the wave-lengths in the visible spectrum were based on Newton's observations of the colours of thin plates. He also explained the principle of the diffraction grating, and by experiments based on the method of Newton's rings he showed that the actinic or ultra-violet rays had shorter wave-lengths than those in the visible. The wave-lengths of the visible spectrum extend from a little below 4000 to a little above 7000 Ångström [2] units, or, roughly, over about an octave. On the infra-red side we have, first, the invisible rays, often referred to as radiant heat, which contain the major part of the energy in the solar spectrum and a greater proportion still of the energy radiated from bodies at a lower temperature. Beyond these we have the long electromagnetic waves of the type we are familiar with in wireless telegraphy. This side of the spectrum extends to waves of infinite length or of zero frequency.

The gap in which we are interested is on the other side of the visible spectrum in the region of waves of shorter length or higher frequency. In 1801 Ritter showed that there was something beyond the violet end of the visible spectrum which blackened chloride of silver. In other words, there are ultra-violet rays which, as we should now say, are capable of photochemical and photographic action. They also have other properties—they excite fluorescence in substances such as uranium glass, and they liberate electrons from the surface of a metal plate. They are, however, not very freely transmitted by glass; or, to put the matter more precisely, the ultra-violet spectrum which is transmitted by a glass prism spectroscope, does not extend very far beyond the visible limit. By substituting quartz for glass in the spectroscope, and by other improvements, Stokes was able to make a very notable extension and to carry the limit to beyond 2000 Å. This made the ultra-violet extend over more than an octave, and measured in that way its extent had become greater than the whole of the visible spectrum.

The limit to further extension was now found to be set by two things—(1) the absorption of quartz, which becomes fatal about 1850 Å, and (2) the absorption of air, which also becomes prohibitive in the same neighbourhood. These difficulties were faced and overcome up to a certain point by Schumann, who constructed a fluorite spectroscope which he could operate, with all its adjustments, in an evacuated chamber. In this way he succeeded in pushing to the limit of transparency of fluorite, which is in the neighbourhood of 1250 Å with good specimens.

The limit to further development was set, and the possible lines of advance narrowed down, by a very remarkable and important property of the radiation in this part of the spectrum, to wit, that every known material substance is practically completely opaque to it. I believe this high absorbability of the radiation to be due to the combined influence of two facts—(1) that the quantum of this radiation exceeds the ionisation or radiation quantum of every atom, and (2) it does not exceed it by so much that there is any considerable chance of the radiation getting past the atom which, as it were, is set to trap it. We have precise evidence that absorption sets in as soon as, but not earlier than, the frequency at which the quantum of the impinging radiation exceeds the ionisation or radiation quantum of the atom. We also have considerable evidence, both theoretical and experimental, that the chance of absorption is greater when the two frequencies are comparable than when they are widely divergent in magnitude. These considerations exclude completely any apparatus of the type of the prism spectroscope, in which the radiation passes through considerable portions of matter such as the materials of the prisms and lenses.

There is one spectroscopic apparatus which is free from this difficulty, namely, the concave grating invented by Rowland. In this device, if the slit, the grating, and the screen or photographic plate are all arranged to lie on a circle perpendicular to the rulings having a diameter equal to the radius of curvature of the grating, the spectrum is sharply focussed without using any lenses. The adaptation of the concave grating for use in this part of the spectrum is due to Lyman, whose vacuum grating spectroscope has only begun to bear the fruit which we may reasonably hope ultimately to gather from it. With this instrument, which I shall refer to more fully later, by 1913 Lyman had measured the wave-lengths of a large number of lines between the limits reached by Stokes (quartz) and Schumann (fluorite), and had also extended the known spectrum to the neighbourhood of 900 Å, which is the short wave limit of the most fundamental hydrogen atom spectrum series, now known as the Lyman series.

At that time, then, the spectrum was known to be continuous from wave-length infinity to wave-length 900 Å, or in terms of frequency from zero to $3{\cdot}333 \times 10^{15}$ vibrations per second. It was also known that we had in the X-rays and the γ-rays from radioactive substances rays of still higher frequency and shorter wave-length. Prior to the discovery of the crystal diffraction phenomena the wave-lengths of X-rays had been ascertained roughly by photoelectric methods—a fact which seems generally to have been forgotten—but by 1913 they had been measured accurately by the Braggs and Moseley with the crystal spectrometer. Moseley's measurements include such rays as the K-rays of aluminium, which are in the neighbourhood of 8 Å, and this was the longest X-ray wave then known. There was thus a gap from 8 Å to 900 Å, or about seven octaves. This is the gap with which I propose to deal.

I do not know that any systematic or very thorough attempt has been made to push the measurements of

[1] Substance of lectures delivered at the Royal Institution on May 13 and 20 1922.

[2] 1 Ångström unit (Å) = 10^{-8} cm.

X-ray wave-lengths so far as possible in the long wave direction by crystal methods, but it is evident that there must be a limit, and it is possible that this limit has almost been attained, for in spite of the great improvement in technique and the extraordinary activity in this line of work since Moseley's measurements in 1913, the longest wave-length I have been able to find recorded as measured is the zinc L_{a_1} line given by Friman as 12·346 Å. This represents but half an octave out of the seven octaves between the limits left by Lyman and by Moseley.

The failure of crystal methods is due to two causes. The distance between the centres of the atoms in solids is of the order of an Ångström unit, so that at 12 Å the waves are already much longer than the distance between the reflecting planes which form the grating elements. (For the crystals rock-salt and calcite, with which most of the accurate measurements have been carried out, these distances are $2{\cdot}184 \times 10^{-8}$ and $3{\cdot}028 \times 10^{-8}$ cm. respectively.) The other difficulty arises from the intense absorbability of these soft X-rays by practically everything, a phenomenon that we have already witnessed in the radiation on the other side of the gap. Sir William Bragg has recently been investigating some organic crystals which have grating spaces very much farther apart than rock-salt and calcite, and it may be that in employing such crystals in an evacuated system we have a way of making considerable advances into the gap from the high-frequency end by the X-ray crystal diffraction methods. It would seem that in Moseley's original apparatus we have an arrangement which could be rather easily developed for this purpose. Another advantage of these crystals is the possibility that they may not absorb the rays so very intensely, as the only known substances which have appreciable transparency in this region are organic compounds or mixtures of them, such as celluloid.

Returning to the position about 1913, this is conveniently exhibited by diagram A of Fig. 1, in which the various spectral limits are marked against an even scale proportional to the logarithms of the corresponding frequencies. These are shown by the numbers on the base line, the numbers given at the top being corresponding wave-lengths in Ångström units. It will be seen that this representation is similar to that of the keyboard of a piano, equal horizontal spacings corresponding everywhere to an equal number of octaves. The great width of the gap between the X-ray and ultra-violet limits is very apparent.

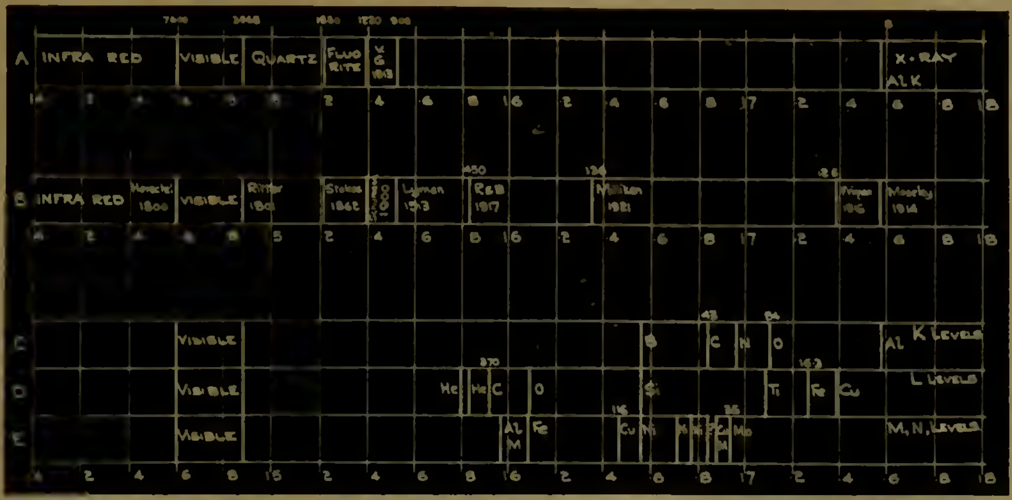

FIG. 1.

A very considerable advance into this gap was made by Dr. Bazzoni and myself in 1917 using a method which was novel in spectroscopy. Our experiments were directed towards the measurement of the short wave limit of the arc spectra of various gases, and more particularly of helium, which are generated when such gases are bombarded by considerable electron currents under moderate voltages (Fig. 2). The radiation from the gas generated under impact of the electrons passing from the incandescent tungsten cathode F to the cold anode A_1, falls on the metal strip T, after passing through the gap between the metal plates P, across which an electric field is maintained of sufficient strength to remove any ions present in the radiation stream. This radiation liberates electrons

FIG. 2.—Horizontal section of apparatus used for the measurement of the short wave-length limit of arc spectra, drawn to scale.

from the surface of T by photoelectric action, and the energy of the swiftest of these electrons is given by the relation $\frac{1}{2}mv^2 = h(\nu - \nu_0)$, where ν is the frequency of the radiation and ν_0 the threshold frequency of the metal T, h being Planck's constant. The velocity v can be measured by applying a magnetic field perpendicular to the plane of the figure, when the electrons will be constrained to move in spiral paths, the axes of which are parallel to the magnetic field. Only those spiral paths the radii of which lie within certain narrow limits will pass through the gaps S_1, S_2. Consequently, since this radius depends on the velocity of the electrons and on the magnetic field, those electrons which reach the box I in a given magnetic field will have velocities lying between corresponding narrow limits. As the magnetic field is increased it will ultimately curl up the fastest electrons, so that their paths projected on to the plane of the figure lie along the circle $TS_2\ S_1$. Any magnetic field greater than this will give rise to spirals which are too narrow to get into the box I, so that the magnetic field, which is just sufficient to stop the electron current into the box, will determine the velocity of the fastest electrons, and from this datum the equation quoted above enables the greatest frequency present in the radiation to be estimated. In this way we determined the end of the helium spectrum to lie close to the position 15·83 on diagram B of Fig. 1. The corresponding wave-length is about 450 Å.

By 1916 Lyman had succeeded in measuring the wave-lengths of various lines extending to about 600 Å by means of his vacuum grating spectroscope. This instrument of course measures the wave-lengths of the lines with precision, and is the most valuable weapon we have for research in this region. Notable advances have recently been made with it by Millikan, who has made several improvements in technique which have contributed to the success he has attained. These improvements include—(1) the production of special gratings which are ruled with a light touch, so as to have about half the grating surface uncut, and thus throw nearly all the energy into the first-order spectrum; (2) the employment of very high-tension sparks (some hundreds of thousands of volts supplied by Leyden jars and a powerful induction coil) between metal terminals very close together (0·1-2 mms.) in a high vacuum maintained by diffusion pumps. With this apparatus he has succeeded in measuring a large number of lines in the extreme ultra-violet spectra of the light elements lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, sodium, magnesium, and aluminium, extending in the case of aluminium to 136·6 Å. This limit is shown at 16·35 on Fig. 1, B.

All these elements exhibit, under these conditions, characteristic line spectra which extend into the ultra-violet, and, roughly speaking, the spectra go further into the ultra-violet with increasing atomic weight of the elements. The spectra differ very much in character as between the different elements; thus boron has but seven strong lines extending between the limits 676·8 Å and 2497·8 Å, whereas carbon has a very complex spectrum extending from 360·5 Å to 1335·0 Å. In fact the spectra of the elements of odd atomic number such as boron tend to be simpler than those of even atomic number such as carbon. The spectra of these elements in this region resemble the X-ray spectra of the heavier elements in this particular, that they consist of groups of lines separated by very wide intervals. Thus with aluminium there is nothing between 144·3 Å (L_α) and 1200 Å, where a new spectrum starts which extends into the visible.

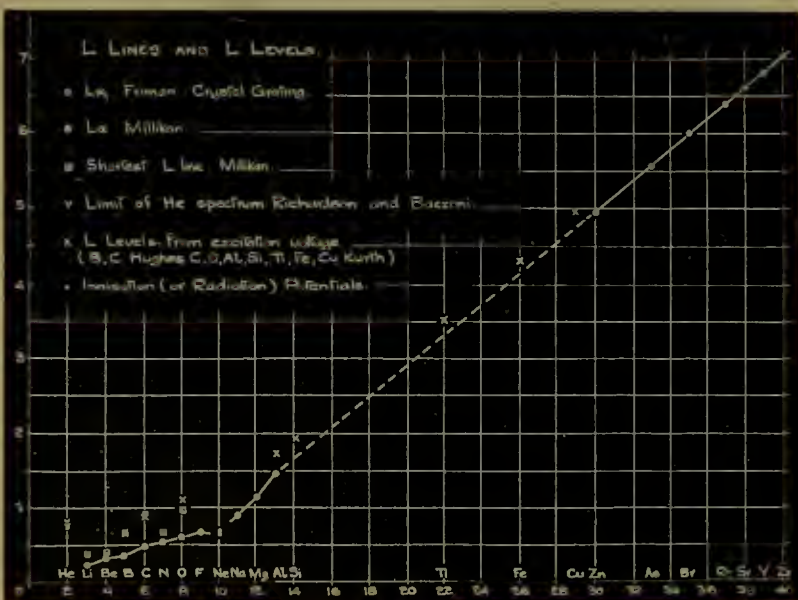

FIG. 3.

There are good grounds for attributing the shorter wave-length groups of the lines of those elements in this region to the L characteristic X-rays of the elements. This will become clear by reference to Fig. 3, which represents the square roots of the various frequencies plotted against the atomic numbers of the corresponding elements. The points encircled between atomic numbers 30-40 (Zn-Zr) belong to the L_{α_1} lines of the elements, the wave-lengths of which have been accurately measured by Friman by the crystal diffraction methods. These points are all practically on a straight line, which, if prolonged in the manner shown by the broken line, reaches the abscissa for atomic number 13 (aluminium) at a value of the ordinate which corresponds almost exactly to the line of wave-length 144·3 Å, which Millikan found to be the longest in his group of aluminium lines in the far ultra-violet. This point is marked thus ⊗ on the diagram. It is of course a long shot from zinc to aluminium, but we shall see later that we have other evidence of the legitimacy of the extrapolation. The other points marked ⊗ refer to the longest lines, and those marked ⊡ to the shortest lines, of the spectra of the various elements of low atomic weight observed by Millikan. It will be seen that the linear relation between the square root of the frequency of corresponding lines and the atomic number which holds for the higher atomic numbers breaks down in this region. In fact, while there is a general tendency for the corresponding frequencies to increase with increasing atomic numbers, one is no longer an approximately continuous function of the other. The vertical spacing between the points ⊗ and ⊡ for any one element is an indication of the extension of the relevant spectrum. It will be seen that this extension varies in an irregular manner in the sequence of elements from lithium to oxygen. The points shown for lithium are those for the well-known red line 6708 Å and the end, 2299 Å, of the series to which it belongs. No lithium lines were found in the ultra-violet beyond 2299 Å in the region in which the vacuum grating is effective; so that if the allocation of these spectra, for the intervening elements up to aluminium, to the L X-ray series of the respective elements is correct, this series is the L series of lithium. This forms very convincing evidence of the essential similarity of X-ray and visible spectra.

(*To be continued.*)

The Natives of Australia.[1]

By SIDNEY H. RAY.

IN the National Museum of Victoria at Melbourne a special gallery has been devoted to a fairly representative collection of objects connected with the daily life of the Australian aborigines. A very instructive and well illustrated account of the exhibits has been written by Sir Baldwin Spencer, and this gives, in a wonderfully succinct form, what are practically short comparative essays on the arts and crafts of the natives.

There seems to be very little doubt that the first inhabitants of Australia were frizzly-haired people of the old Stone Age, using unground axes, chipped stone knives, and scrapers without handles. They had no knowledge of boats or house-building. Part of this population, cut off by a subsidence which now forms Bass Straits, survived in Tasmania until modern times, but on contact with Europeans became exterminated. In the Museum these people are represented by masks of two males and one female and by a cast from the skeleton of Truganini, the last of the Tasmanians. There is also a collection of their stone implements.

On the mainland the primitive population was supplanted by people in a higher grade of development whose origin is still a matter for discussion. These people are remarkably uniform throughout the continent. The average height is about 5 ft. 6 in.; the skin a dark chocolate colour and never really black; the head long, the hair wavy, not woolly or frizzly like that of the Tasmanian, Papuan, or Negro. The people are nomadic, living in tribes which have distinctive names, and roam within certain clearly defined limits. They have no villages but only camps or clusters of rude shelters. One of the Museum cases contains a representation of a native camp, Fig. 1. This shows the *mia-mia* or shelter made of bark from gum trees resting on the windward side of a rough framework and forming a sort of lean-to. The man and woman are supposed to be returning from a hunting expedition. The woman carries in her hand her digging stick, and on her back a young child secured in its position by the skin cloak. The latter is usually of opossum skins, sewn together with sinews often taken from a kangaroo's tail. The head of the clothed man is decorated with a string forehead band in which are stuck feathers of the black cockatoo. But generally the men wear no clothing. The man in the foreground is making fire with a drill. In connexion with the camp, the *toas* or posts set up by South Australian tribes on departure as a guide to new-comers (see NATURE, February 12, 1920, p. 643) do not appear to be represented in the Victorian collection.

FIG. 1.—Native camp scene.

The languages used differ so much that natives of one tribe cannot understand the speech of their neighbours, and though in some regions, owing to the absence of mountains and rivers, tribes may be closely associated and a few words understood, there is even between these very little community in actual speech. In the Northern Territory the languages appear entirely different in grammatical structure from those in South, West, or East Australia, and approach in character

[1] "Guide to the Australian Ethnological Collection" exhibited in the National Museum of Victoria. By Sir Baldwin Spencer. 142 pp. Third Edition. Illustrated by 33 Plates. Melbourne: Albert J. Mullett, Government Printer, 1922.

the Papuan tongues of New Guinea. Throughout the Australian continent gesture language is very highly developed and forms a ready means of communication when words fail.

FIG. 2.—Ceremonial objects.

Much has been written about Australian tribes. Most of them have a very definite organisation and are divided into at least two main divisions (sometimes four or eight). Men of one group must marry women of the other, the children belonging sometimes to the father's division, sometimes to the mother's. Relationship names refer to the members of the group. Thus a man uses the term "father" not only for his real father but for all his father's brothers. His "mother" is any of the women whom his father might have lawfully married, and his "brothers" are not only his blood brothers but also his father's brother's sons.

Another social system which is greatly developed among the Australian aborigines is based on the *totems*. As defined by Sir J. G. Frazer, a totem is "a class of material objects which a savage regards with superstitious respect, believing that there exists between him and every member of the class an intimate and altogether special relation." In Australia the totem is an animal or plant, and the native describes himself as a kangaroo, snake, or gum-tree man as the case may be. Some tribes perform ceremonies to increase the totem animal or plant, while in others men may not eat or injure their totem. Sometimes the tribal organisation is based on the totems, sometimes it is sexual, and the women have different totems from the men. Often the totem regulates marriage.

Social organisations and ceremonies are controlled by men whose age, fighting power, or skill in magic make them prominent; but there are no chiefs. The passage from youth to manhood is marked by submission to painful rites of initiation. The knowledge of the sacred or secret ceremonies connected with initiation is forbidden to women and children under severe penalties. Many of the sacred objects connected with these ceremonies, and with the totems, are prominent in the Victorian collection (Fig. 2). They comprise *churinga* (sacred stones and sticks associated with the totems), wands, slabs, and decorations used at initiation.

No Australian weapons are made of metal. Bows and arrows are unknown. Spears are sharpened wooden sticks with barbs attached or cut near the point. Sir Baldwin Spencer describes twelve main types. In some places they are tipped with bone, flaked stone, or spines from the echidna or the sting-ray. The spear is launched by a spear-thrower. This is a stick with a point at one end which fits into a hole in the spear-shaft and gives leverage and accuracy of aim. Spear thrusts are warded off by shields, which are often highly decorated. Clubs of various forms are also used. The most distinctive Australian weapon is the boomerang. This was apparently not used by the Tasmanians. It is a curved throwing weapon varying in size and use, and most of the eastern and southern coastal tribes make a "return" boomerang which when thrown comes back to the thrower.

FIG. 3.—Baskets.

The weapons and implements exhibited have been arranged so as to show their development in various parts of Australia. Thus one of the cases shows transition from an ordinary throwing-stick to a boomerang and thence to a large double-handed sword-like weapon. Another case shows a transition from a stick to various shapes of knobbed clubs. Two of the latter from Queensland with teeth in the swollen part are suggestive of the "pine-apple" clubs of New Guinea.

The stone implements in the Museum are of special interest. Sir Baldwin Spencer points out that there is no essential difference in type throughout Australia, neither is there any evidence of distinct stages of culture which might be called eolithic, palæolithic, or neolithic. Stone implements which, if discovered in Europe, would be assigned to these stages are found in use in the same camp and district at the present time. The cutting edges of knives and other implements are produced by flaking or chipping, or by grinding and polishing suitably shaped pebbles or cut lumps of stone. Spear-heads and knives are hafted with resin. Spear-heads made of glass, used since the advent of the white man instead of quartzite, are shown in one of the cases. The finely serrated edges are produced by pressure of a kangaroo bone broken and ground into a gouge-like form.

Fire is produced by drill or saw. A piece of hard wood is either rapidly rotated or worked up and down in a groove upon a softer piece, the powder worn away being ignited by the heat of the friction.

Bowls are hollowed from blocks of wood, partly by gouging, partly by burning. Baskets are plaited from grass-stalks, rushes, thin pliant twigs, or split cane. Sometimes they are open, sometimes close enough to contain honey or water. The close baskets are often decorated, as in those from Northern Territory shown in Fig. 3.

String in some places is made of human hair, but in others the possession of the hair of a person gives its possessor power to work harm upon the man from whom it has been cut. String is also made of vegetable fibre, sinew, and fur. Personal ornaments are made of fur, feathers, wood, bone, or shell.

Native art is well represented in the Museum collection. It consists of rude drawings of animals and plants and geometric designs drawn with yellow or red ochre, white pipeclay, and charcoal, or incised drawings with the sharp-edged tooth of an opossum or a flake of flint.

Among the descriptions of the exhibits Sir Baldwin Spencer has given many notes on their use. He has provided a most instructive and useful guide, which cannot fail to interest the student and stimulate the study of Australian ethnography.

Long-Distance Radio Telephony.

THE successful transmission of speech from New York to London, which took place in the early hours of the morning of January 15, shows that the difficulties of long-distance radio telephony are being overcome. The main difficulties are due to absorption of the radio-waves and the muffling of the sounds produced by extraneous noises due to atmospheric disturbances. By carrying out the experiment at night, when the absorptive effects are a minimum, and during the winter months, when the atmospheric disturbances are least, the chances were all in favour of a successful issue. During the first half-hour of the two hours' test, however, the cracklings due to the atmospheric disturbances were plainly audible. Since January 1 measurements have been made daily at the New Southgate Works of the Western Electric Co., Ltd., of the intensity of the signals and of the atmospherics respectively. The results for the first fortnight show that the amplitude of the disturbance due to the atmospherics was less than ten per cent. of the average amplitude of the signals for fourteen hours out of the twenty-four. At this period of the year it is only from 1 P.M. to 11 P.M. Greenwich time that transatlantic telephony is unsatisfactory. When the measurements have been carried out systematically for a year, it will be possible to estimate with fair accuracy the cost of a radio transmission system of satisfactory quality.

It has been found that although the Austin formula gives the daylight strength of radio signals with high accuracy for hundreds of miles over the sea, yet when the distances are measured by thousands of miles it cannot be used. The night values of the signals when the circumstances are favourable can be accurately calculated, as the damping effects are then negligibly small. In the recent test a small frame aerial was used, for the constants of such an aerial can be readily calculated. As there were sixty listeners, each with a head set, considerable amplification had to be employed, and so the test was a specially severe one. Amateurs in this country have occasionally picked up both speech and music sent out by the American broadcasting stations. These, however, are "freak" receptions due to several favourable conditions occurring simultaneously. For commercial radio telephony, communication must be possible at definite times of the day under practically all atmospheric conditions.

In the test the total distance traversed by the speech was first 70 miles by telephone cable from New York to Long Island, where there is a radio station with an antenna 1¼ miles long, supported by towers 450 feet high. About sixty kilowatts had to be supplied to this aerial. A notable economy of power was effected by suppressing the carrier wave between the radio-transmitting and the radio-receiving station, a distance of about 3000 miles. It has to be remembered that the speech could have been sent out with practically equal clearness from any point on the vast long-distance telephone network of the United States.

There can now be no reasonable doubt that transatlantic telephony is possible during a large fraction of the year, and it is quite probable that the result of the tests now being made at New Southgate will demonstrate that radio telephony between Europe and America will be feasible on a commercial basis. This will doubtless have important results on the world's future. It is to be hoped that rapid communication will prevent many of those misunderstandings which too frequently arise between nations.

Obituary.

Prof. J. B. Haycraft.

PROF. JOHN BERRY HAYCRAFT, who died suddenly on December 30, was a figure better known to the older than to the younger generation of British physiologists. A serious illness, which fell upon him (as it fell upon Pasteur) in middle age, affected his scientific work; and the promise and fulfilment of his earlier period have to a certain extent been dimmed.

Haycraft devoted his life to physiology. Throughout it—in spite of ill-health—he held before him the ideal of scientific research. After graduation at Edinburgh he studied abroad in Leipzig. Then, while demonstrator in the physiology laboratory at Edinburgh with Rutherford, professor at the Mason College in Birmingham, interim professor during Rutherford's illness at Edinburgh, and finally professor of physiology at Cardiff, he steadfastly pursued his scientific investigations.

Haycraft's best-known works to-day are perhaps his contributions on animal mechanics and on the senses of taste and of smell in Sir Edward Sharpey Schafer's "Text-book of Physiology"; and his best-known original contribution to physiology is probably his paper on the cross-striation of skeletal muscle (1891). In this latter work he used the ingenious method of taking casts of muscle fibre upon collodion. The impression of the fibre upon the collodion showed the same cross-striated appearance as the original muscle fibre, and Haycraft inferred that the cross-striation is an optical phenomenon due to the varicose shape of the muscle fibrils, which gives different refraction effects in the globular and in the restricted portions of the fibril.

But Haycraft's range of investigation was a wide one: the results of temperature variation (1879); the chemistry of the blood, its coagulation, etc. (1879, 1882, 1884, 1888, 1891); special sense physiology—vision, taste, smell (1883, 1884, 1885, 1887, 1893, 1897, 1910); various contributions to chemical physiology (1889, 1891, 1894); contributions to histology (1879, 1880, 1889, 1890), and to development (1891, 1893, 1895); a theory of amœboid movement (1880); the "muscle sound" (1890); voluntary movements (1890, 1898); the scratch-reflex (1890); elasticity of animal tissues (1904).

Haycraft's chief interest was, however, the physiology of the heart. He published a series of papers in this field: the cause of the first sound (1890); the movements of the heart within the chest (1891); the time of contraction of the papillary muscles (1896); and the changes in shape of the heart during the cardiac cycle (1896)—the two latter papers in collaboration with Paterson. When he resigned his chair in 1920 it was with the intention of continuing his researches on the circulation, and up to the time of his death he applied himself to problems of the pulse-wave in the physiological laboratory at Cambridge.

Haycraft's illness left behind it an impairment of speech which made the expression of his thoughts sometimes a matter of difficulty. This defect in the mechanism of expression was a severe handicap, but did not dim the clearness of his vision and ideals. So far from this being the case, it was in the later part of his life that his vision was crystallised in the development of the Welsh National School of Medicine, and in the Physiology Institute at Cardiff, which will be his chief monument.

In his long tenure of the chair at Cardiff—from 1894 to 1920—Haycraft saw and guided the development of the medical school there until it became the Welsh National School just after his retirement. The modern organisation of that school on the basis of a compulsory degree in science for all its medical graduates, a six years' course of study, and whole-time professors in the clinical subjects, owes to Haycraft more than is commonly realised.

Haycraft insisted that physiology must be the basis of medical education, and fought long for the establishment of a modern laboratory in Cardiff. He was exceptionally fortunate in finding a munificent patron in Sir William James Thomas, Bt., and an enthusiastic architect in the late Col. Bruce Vaughan. The result of this collaboration was the building of the magnificent Physiology Institute in spite of endless discouragement and delay. That Institute, even in its incomplete form one of the largest in the country, carries evidence of his foresight in its detail and arrangement; it is one of the most modern and best planned of physiology laboratories.

His friends will remember Haycraft for his determination in face of opposition, for his vision, and for his high ideal of science; but most perhaps for this, that in spite of all the difficulties which he had to face, he did no mean thing. He was a gentleman, and the magnificent institute which was his vision is his fitting memorial. T. G. B.

Sir John Gavey.

SIR JOHN GAVEY, who died on January 1, at the age of eighty, was one of the most notable telegraphic and telephonic engineers in this country. He was born at St. Helier in Jersey and began his career in the Post Office in 1870. In 1902 he became Engineer-in-Chief and Electrician to the General Post Office. He was made a Companion of the Bath in 1902, and on his retirement in 1907 a knighthood was conferred upon him.

In his early days at the Post Office, Gavey originated many improvements which greatly increased the speed of automatic telegraphy, and in 1881 he opened the first telephone trunk line connecting two British towns, namely, Newport and Cardiff. In 1894 he succeeded in establishing communication between the opposite sides of Loch Ness, a distance of four miles, by means of the electromagnetic induction between two parallel wires stretched along the banks. This method was subsequently used for establishing communication between lighthouses and the mainland. Gavey was responsible for the organisation of the complete telephone trunk system for Great Britain, and he organised the Post Office telephone exchange system for London. He joined the Institution of Electrical Engineers in 1872, the year after it was founded, and communicated several valuable papers to it. In 1905 he gave in his presidential address to the Institution a masterly summary of telegraphic and telephonic progress, and a list of unsolved problems which proved very useful in directing the ingenuity of inventors along promising lines.

Sir John Gavey served on many international committees, including some of the earliest on radio-communication. He was one of the first to appreciate the importance of Oliver Heaviside's theoretical investigations, and to use Duddell's oscillograph in everyday experimental work. He was very highly esteemed by every one who came in contact with him, and the work he did at the Post Office has proved of the greatest value.

MR. A. H. CURTIS.

By the death of Alfred Harper Curtis on January 10, after a few days' illness, the Imperial Mineral Resources Bureau loses a very able and highly-esteemed member of its staff. Mr. Curtis was the second surviving son of the late Alfred Curtis, Town Clerk of Neath, Glamorganshire, and was born on July 12, 1863. Having chosen the profession of engineering, he early gave a practical bent to his studies. As a youth he spent three years with an engineering firm in the Swansea district, and during that time acquired a good knowledge of mining and metallurgical processes. He then proceeded to Owens College, Manchester, where he studied civil engineering and geology, after which he took up the study of mining, mine surveying, and other subjects at the Royal School of Mines, London, and graduated as B.A. at the University of London.

On leaving the Royal School of Mines, Mr. Curtis travelled widely in many parts of the British Dominions and foreign countries, spending long periods in New Zealand and Japan, investigating and developing mineral deposits. His paper on "Gold Quartz Reduction," read at the Institution of Civil Engineers in 1891–1892, gained for him the Telford premium. While in New Zealand, during the period 1896–1902, he was a member of the council and one of the honorary secretaries of the New Zealand Institute of Mining Engineers, to which, in 1898, he contributed a paper on "The Examination and Valuation of Mines."

During the war Mr. Curtis gave much time to the preparation of reports dealing with the mineral resources of the British Empire and foreign countries. In this capacity he worked for a short time at the Imperial Institute, and compiled the publication on "Manganese Ores" issued by the Institute. He later joined the staff of the Imperial Mineral Resources Bureau, and took a prominent part in the compilation of the statistical and descriptive reports issued by the Bureau.

Mr. Curtis was an untiring and conscientious worker, and his death leaves a gap that it will be difficult to fill.

Current Topics and Events.

At the meeting of the Chemical Society held on Thursday, January 18, it was announced that the council had nominated Prof. W. P. Wynne to fill the office of president, which will be vacated by Sir James Walker on March 22.

The gold medal of the Royal Astronomical Society has been awarded by the council to Prof. A. A. Michelson, for his application of the interferometer to astronomical measurements. It will be presented at the annual general meeting to be held on Friday, February 9.

Prof. R. A. Sampson, Astronomer Royal for Scotland, has been appointed General Secretary of the Royal Society of Edinburgh for the remainder of the current session, in succession to the late Dr. C. G. Knott.

Sir Edward Sharpey Schafer has accepted an invitation to deliver in London next autumn the first Victor Horsley memorial lecture. The lecture, which will be given triennially, is the outcome of the work of a committee formed in 1920 to commemorate the services of Sir Victor Horsley to science and the British Empire. The subscriptions received by the committee amounted to more than 1000*l*.

At the meeting of the Institution of Electrical Engineers to be held on Thursday, February 1, the president will present to Mr. J. W. Meares, late local honorary secretary of the Institution in India, and Electrical Adviser to the Indian Government, a salver and cigarette box subscribed for by his friends in India on the occasion of his retirement from the Indian Government Service, and as a token of his valuable services to the profession in India.

The Air Conference, to be held at the Guild Hall on February 6 and 7, will be opened by the Lord Mayor of London. During the Conference the following papers will be presented and discussed: "The Position of Air Transport To-day," by Maj.-General Sir W. S. Brancker; "A Self-supporting Airship Service," by Commdr. C. D. Burney; "The Progress of Research and Experiment," by Air Vice-Marshal Sir W. G. H. Salmond; "Gliders and their Value to Aeronautical Progress," by Col. A. Ogilvie; "Seaplanes," by Mr. C. R. Fairey.

On Tuesday next, January 30, at 3 o'clock, Mr. R. D. Oldham will begin a course of two lectures at the Royal Institution on the character and cause of earthquakes; and on Thursday, February 1, Prof. I. M. Heilbron will deliver the first of two lectures on the photosynthesis of plant products. The Friday evening discourse on February 2 will be delivered by Mr. C. F. Cross on fact and phantasy in industrial science, and on February 9, by Sir John Russell, on Rothamsted and agricultural science.

The Grocers' Company is offering a scholarship (one of three), of the yearly value of 300*l*., with an allowance for necessary expenses, the object being to encourage original research in sanitary science. The appointment will be for one year, but it may be renewed for a further second or third year. The election will take place in May next. All applications must be sent before April 1 to the Clerk of the Grocers' Company, Grocers' Hall, E.C.2, upon a special form obtainable upon application.

THE Riverbank Laboratories for research in Acoustics, Geneva, Ill., U.S.A., are establishing one or two research fellowships in acoustics, and invite applications for the same from college graduates who have taken advanced courses in physics and mathematics, and shown in their work qualities essential for success in independent investigation. The terms of appointment will be determined by the qualifications of the person or persons appointed. Applications should be sent to Mr. B. Cumming, Secretary, The Riverbank Laboratories, Geneva, Illinois, U.S.A.

THE Minister of Health has appointed the following representatives of the British Waterworks Association and the Institution of Water Engineers as a standing advisory committee to confer with representatives of the Ministry on questions of water supply: Mr. C. S. Musgrave, Mr. A. R. Atkey, Mr. A. B. E. Blackburn, Lieut.-Col. J. R. Davidson, Mr. F. W. Macaulay, and Mr. W. Terrey. The subjects discussed at the committee's first meeting included (1) the steps to be taken for formulating the outlines of a national water policy; (2) the survey of the water resources of England and Wales; and (3) the standardisation and testing of water fittings.

MR. R. I. POCOCK is retiring next March from the post of superintendent of the Zoological Gardens, Regent's Park, to which he has been attached since 1904, and the council has appointed Dr. Geoffrey Marr Vevers to succeed him. Dr. Vevers is at present a Beit Memorial Research fellow and an assistant at the London School of Tropical Medicine. He will have as his staff Mr. D. Seth-Smith as curator of mammals and birds, Mr. E. G. Boulenger as curator of the aquarium and of reptiles, and Miss L. E. Cheesman as curator of insects. Dr. R. W. A. Salmond has been appointed honorary radiologist and Prof. G. H. Wooldridge as honorary consulting veterinary surgeon to the society.

PROF. ALFRED LACROIX, president of the Geological Society of France, has been selected as the recipient of the Hayden memorial geological award for 1923 of the Academy of Natural Sciences of Philadelphia. The award, which is made every three years, and consists of a gold medal, was founded in 1888 in memory of Dr. Ferdinand V. Hayden, at one time director of the United States Geological Survey, "as a reward for the best publication, exploration, discovery or research in the sciences of geology and paleontology." Prof. Lacroix is well known among geologists; he was made professor of mineralogy at the Paris Museum of Natural History in 1893, and in 1901 he was elected a foreign member of the Geological Society, from which he received the Wollaston medal in 1917; in 1904 he was elected a member of the Paris Academy of Sciences, and for the past eight years has been permanent secretary for the physical sciences. His work includes studies of contact and endomorphic metamorphism and a detailed investigation of Mont Pelée. Among previous well-known recipients of the award are Suess, Huxley, Sir Archibald Geikie, Dr. Charles D. Walcott, Prof. H. F. Osborn, and Prof. T. C. Chamberlin.

MR. E. D. SIMON, late Lord Mayor of Manchester, has arranged with the Rothamsted Experimental Station to devote the whole of his farm and dairy herd at Leadon Court, Herefordshire, to a thorough test of the soiling system designed by Mr. J. C. Brown, formerly of the Harper Adams Agricultural College, in which a dairy herd is maintained largely on the produce of the arable land. Mr. Simon has obtained Mr. Brown's services as resident manager, and has authorised the Rothamsted authorities to publish all or any records and accounts that may be deemed helpful to farmers. It is believed that Mr. Brown's system will prove of great value; but in these difficult times the ordinary farmer could not afford to experiment on his own account, and the trial requires more land and dairy cows than could be provided at a college or an experimental farm. The experiment will serve a valuable purpose in showing how far the various modifications introduced will be financially advantageous to the dairy farmer, and agriculturists generally will greatly appreciate Mr. Simon's generous action.

ATTENTION was recently directed in these columns (November 11, p. 642) to the probable use of the cinema in England and France as a means of agricultural education among farmers. It is interesting to note that the United States Department of Agriculture has employed this method for the last nine years. At the present time they have 150 films available dealing with many branches of farming activity, and with rural life generally. Special attention is paid to the control of disease, both of animals and plants, and the best methods of crop production. The American parks and game preserves, which are in the charge of the Department of Agriculture, also receive attention, and their value to the nation is illustrated from many points of view. It is probable, however, that the films dealing with Extension Service activities of the Department are the most important. Of recent years the development of cooperation, both for the business interests and the amenities of rural life, has proceeded at an ever-increasing rate. There is no doubt that the progress of this movement has been, and will be, greatly stimulated by the use of films; they cannot, of course, replace in any way the valuable personal contact with the farmer, which is the corollary of an adequate research and advisory service, but they can help greatly in disseminating a general idea of the expert assistance that is available.

ON two previous occasions last month (December 2, p. 743, and December 30, p. 884) we referred to film displays in connexion with the Mount Everest Expedition of 1922. Another effort to place before the public a record of the results obtained, is the exhibition of pictures at the Alpine Club Hall, Mill Street, Conduit Street, W.1. These pictures, which will be on view until February 6, include some 152 photographs and 52 paintings in oil and water colour. The photographs are chiefly by Capt. Noel, showing the personnel of the expedition, the camps and ground traversed, and the Tibetan people. Among the last-named group are several of the Rongbuk monastery and its inmates, including two telephotographs of the Chief Lama, who, as the supposed incarnation of the god Chongraysay, could not be approached sufficiently for an ordinary photograph. There are several fine photographs of the East Rongbuk glacier by Capt. Finch, some of them showing the tremendous ice-pyramids which had to be traversed, varying in height from 30 to some 300 feet. At nearly 23,000 feet the Chang La camp was pitched in very curious surroundings; the peculiar snow formation shown behind the camp in the picture was only met with at this place. The photographs follow the climbing to a height of some 26,000 feet, and one shows the party a few minutes before the disastrous avalanche. The view of Changtse and Gyachung Kang from Mount Everest, taken at an altitude of 26,985 feet by Mr. Somervell, creates a record in photography. Among the more striking scenic effects are the wind-blown snows on the east slopes of Everest, and the sunset on the north face. Copies of the latter photograph and several others of the collection may be purchased. The impressive scenes in water colour and oil by Mr. T. Howard Somervell are also for sale. The proceeds will be spent on a third expedition.

THE weather over England in 1922 had no outstanding feature like the drought in 1921, and it will go down to posterity as a fairly normal year meteorologically. Heavy gales were somewhat more frequent than in late years, especially over the southern portion of the Kingdom. Observations at the Royal Observatory, Greenwich, show that the mean temperature for the year was 49·4° F., which is 0·7° less than the normal, using the period of 35 years, in agreement with the system adopted by the Meteorological Office. The warmest month was June with a mean temperature of 60·3°; this was the only month with the mean temperature above 60° and the only month with the mean of the maximum readings above 70°. January, February, May, June, and December were the only months with an excess of temperature. The coldest month was January, with the mean temperature 40·3°, which is 1·7° above the normal. There were two days in May with the shade temperature above 90°, and there was one day in January, April, October, and December with the shade temperature less than 25°. Rainfall for the year, using the results for the civil day, measured 23·24 inches, which is 0·26 in. less than the normal. July was the wettest month with 3·20 in., which is 0·06 in. above the normal; the next wettest month was December with 2·92 in., which is 0·66 in. more than the normal. October was the driest month, with the total rainfall 0·93 in., which is 1·60 in. less than the normal. Rain fell in all on 178 days, which is 15 days more than the normal, and in both January and July rain fell on more than 20 days. November had only 8 days with rain. Sunshine was registered at Greenwich for 1469 hours, which is 9 less than the normal: the sunniest month was May with 284 hours, the least sunny, November with 26 hours.

THE January number of the *Museums Journal* prints the report of a committee appointed by the National Society of Art Masters, the Incorporated Association of Headmasters of Secondary Schools, the Association of Headmistresses of Girls' Secondary Schools, and the Museums Association, to inquire how far the system of circulating objects from the Victoria and Albert Museum meets the needs of the provinces. Besides recommending that the circulation collections should be systematically completed and brought up-to-date, the committee suggests that the local museum might become a local sub-circulation department of the Victoria and Albert Museum. It ends by pointing out that, "whilst the total vote for Education has grown enormously, the sum allocated for the museum side of Art Education in the Provinces has been practically stationary for generations, and bears no proper relation to the sum available for education as a whole." And yet on its museum side Art Education is treated generously as compared with other branches of education.

AUTHORS and readers will be interested in the authoritative statistics of the cost of book production published in the excellent new Catalogue of the publications issued by Mr. Milford for the Oxford University Press. In the year ending March 31, 1914 the Press issued 157 new books at the average price of 7*s*. 11*d*., or 0·37*d*. per page. The corresponding figures for the year ending March 31, 1922 were 115 books at the average price of 11*s*. 10*d*., or 0·64*d*. per page. These figures concern only those books, in their nature unremunerative, which the Press produces as a service to education and learning. "It will be readily understood that the cost of the present output is higher than that of the pre-war output (though the rise in the price to the public does not show an equivalent increase); and the moral is easily drawn, that the output can be restored to the old level only by the activity of the Press in the production of remunerative books and by increased support from the public." It may be also noted that the concluding volume of the Oxford Dictionary will, when completed, have cost not less than 50,000*l*.

IN the article on the last report of the Development Commissioners, which appeared in NATURE of December 30 (vol. 110, p. 805), the statement was made "that the report does not contain, as in the past, an account of the present finances of the Fund." The Secretary to the Commissioners writes to point out that this statement, which we regret, is incorrect; for such an account does, in fact, appear in the body of the report, and it shows that the balance at the credit of the Fund on March 31 last was 1,337,336*l*., including 850,000*l*. received under the provisions of the Corn Production Acts (Repeal) Act 1921. The advances made during the year 1921–22 were, in the aggregate, 385,185*l*. The *net* balance available for annual advances to meet the cost of existing schemes is stated to be 128,000*l.* only, against an estimated requirement of 200,000*l.* There may be some ground, therefore, for the apprehension expressed in the article as to the future adequacy of the Fund.

REFERRING to a remark made in the notice of his book "The Supremacy of Spirit" in NATURE of January 13, p. 45, Mr. C. A. Richardson writes to say that his purpose was not to attempt to deal at all adequately with scientific objections, but to show that (1) the evidence for the alleged facts is now of such a kind as to merit serious consideration and investigation by a scientific committee; (2) the alleged facts are in terms of his philosophical theory.

THE January list of new books and new editions added to Lewis's Medical and Scientific Circulating Library during October–December has just reached us. Although intended primarily for subscribers to the library, it should be of service to many others, being a general guide to medical and scientific works published in the past three months. The list, which is classified according to subjects, is to be obtained free of charge from Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, W.C.1.

THE spring announcement list of the Cambridge University Press contains particulars of many forthcoming books of science. Among them we notice "The Air and its Ways," by Sir Napier Shaw, being the Rede Lecture for 1921, and other papers dealing with the physical explanation of the atmospheric circulation and with the application of meteorology to agriculture; "Relativity," forming the second of the supplementary chapters to Dr. Norman R. Campbell's "Modern Electrical Theory"; a newly arranged and enlarged edition of "The Mathematical Theory of Relativity," by Prof. A. S. Eddington; the "Collected Scientific Papers" of the late Dr. J. Aitken, containing some thirty-seven papers on atmospheric dust, fogs and clouds, air temperatures, and other scientific subjects, added to which is a sketch of the life and work of the author; and "Glass-Making in England," by the late H. J. Powell of the Whitefriars Glass Works, in which an account of glass-making in all its branches is given from the Roman period to the Great War.

Our Astronomical Column.

OCCULTATIONS OF STARS BY THE MOON.—On the night of January 27, the moon will pass over a number of the stars forming the well-known group in Taurus called the Hyades. The bright star Aldebaran is among those which will be hidden. The times of occurrence for four of the brighter stars will be as under:—

	Mag.	Disappears. h.	m.	Reappears. h.	m.
γ Tauri	3·9	2	57	3	57
θ' Tauri	4·2	8	31	8	56
+15° 637	4·8	9	26	10	39
Aldebaran	1·1	12	35	13	30

The moon will be about 10½ days old at the time and the stars will disappear at the unilluminated side, and reappear at the bright edge of the disc.

The event may be witnessed with a small telescope, and it is possible that Aldebaran may be seen by acute, unaided vision nearly up to the time of its disappearance, which will occur 35 minutes after midnight. The moon will be due south at 8^h and will be 55 degrees above the horizon at the time. There will be four other occultations of Aldebaran during the next 12 months, on March 23, October 27, November 24, and January 17, 1924.

OBSERVATIONS AT WALLAL OF THE ECLIPSE OF SEPTEMBER 1922.—The winter number of the *Chaldaean* (vol. v., No. 17) contains an interesting account of the observation of the eclipse at Wallal on the west Australian coast by Messrs. J. Hargreaves and G. S. Clark-Maxwell. Their principal instrument was the 19-ft. camera with lens of 4-in. aperture lent by Father Cortie, and the 8-in. coelostat lent by the Royal Irish Academy; these were the same instruments as were used at Sobral, Brazil, in 1919, when they gave a result in close accord with Einstein's predictions. But in 1922 the stars were too faint to be photographed with a ratio of aperture to focal length 1/57, and the instrument was simply used as a coronagraph. A large number of successful exposures were secured with a range of 1 to 80 seconds, so that they should give good details both in the inner and outer regions. Successful plates were also secured with the smaller cameras; a declinometer, to record magnetic variations during totality, failed owing to a smoky lamp. The darkness during totality is stated to have been considerable, necessitating the use of lamps for plate-changing, etc. The extension of the corona on some of the plates is 4 solar diameters, which is quite satisfactory.

A gale rendered re-embarkation very difficult, one boat sinking in the surf. None of the important pieces of apparatus were in it, and the articles were recovered. This experience shows that it would have been quite impossible to land the very heavy packages of the Christmas Island party at Wallal; it is a slight mitigation of the disappointment that they suffered to realise that they chose the only station that was reasonably possible in the circumstances.

SPECTROSCOPIC PARALLAXES OF A-TYPE STARS.—The earlier spectroscopic parallaxes were restricted to types F, G, K, M; but, as was recently noticed in this column, Messrs. Adams and Joy have found that the state of sharpness or nebulosity of certain metallic lines in the spectra of stars of type A forms a trustworthy guide to absolute magnitude. The calibration of the correlation curves is effected both by trigonometrical parallaxes and by the group parallaxes of stars in moving clusters. The average differences of the spectroscopic and trigonometric parallaxes (without regard to sign) are $+0{\cdot}0131''$ (104 stars), spectroscopic and group parallaxes $+0{\cdot}0077''$ (82 stars). The systematic differences are $0{\cdot}0000''$ and $-0{\cdot}0014''$ respectively. A list is given (*Astrophys. Journ.*, November 1922) of 544 spectroscopic parallaxes of stars in Boss P.G.C., including a number of members of the Taurus, Perseus, and Praesepe streams. The parallax of Praesepe is given as $0{\cdot}013''$.

A test of the values found is afforded by plotting parallax against proper motion. The resulting graph is nearly straight, showing an increase of proper motion from $0{\cdot}000''$ to $0{\cdot}400''$ as the parallax rises from $0{\cdot}009''$ to $0{\cdot}058''$. It is found advisable to omit Sirius, the large parallax of which unduly affects the mean of its group.

Data are still wanting for finding the parallaxes of stars showing the *c* characteristic, α Cygni being the leading example. Its absolute magnitude is estimated as -4 or -5.

Research Items.

WEAVING IN ANCIENT EGYPT.—Mr. Winlock's discovery of a model weaving shop in the XIth dynasty tomb of Mehenkwetre at Thebes has caused a fresh revival of interest in the subject of ancient Egyptian looms. Two articles in *Ancient Egypt* (Part iii., 1922) are devoted to branches of this subject. Mr. Winlock deals with heddle-jacks and Mr. A. C. Mace with loom weights in Egypt. Some interesting pictures from other tombs dealing with processes of weaving render it easy to follow the lucid descriptions in the text.

BRASS-CASTING IN THE CENTRAL CAMEROON.—The methods of the artists who produced the remarkable series of brass-casting at Benin are illustrated in a paper by Mr. L. W. G. Malcolm, published in the January issue of *Man*. Mr. Malcolm found the art confined to the area in south-west Adamawa, the principal towns being Bamum and Bagam. As a rule the material now used is of European origin. In the north it appears that tin was formerly brought from northern Nigeria, and it has been suggested that copper may have come from the Katanga area of the Congo. In all cases the casting is done by the *cire perdue* process. The articles produced by the Eghāp tribe are generally pipe-bowls, personal ornaments, grotesque animal and bird forms, perfume flasks and bells. Several interesting examples of tobacco pipes used by the Eghāp head-men are illustrated by Mr. Malcolm.

TRIASSIC REPTILES AND STEGOCEPHALIANS FROM TEXAS.—Publication No. 321 of the Carnegie Institution of Washington is devoted to "New Reptiles and Stegocephalians from the Upper-Triassic of Western Texas," by E. C. Case. After sketching the geology of the borders of the Staked Plains in Texas and New Mexico, where these fossils occur, the author proceeds to the description of *Buettneria perfecta*, a new genus and species of Stegocephalia, that has its nearest relations in Metoposaurus. There follows a full description of *Desmatosuchus spurensis* and the sub-order Desmatosuchia, which were originally described by Case in 1920, accompanied by a restoration of *D. spurensis*. Of new parasuchians there are *Promystriosuchus ehlersi*, a fully mature phytosaur of the Mystriosuchid group, of small size and distinct in its characters from any previously described, and *Leptosuchus crosbiensis* and *L. imperfecta*. Descriptions of isolated bones of parasuchians and the remains of a small dinosaur, with notice of some coprolites and a small fragment of a jaw containing a singularly shaped tooth reminiscent of the teeth of Diadectes, terminate this important monograph, which is well got up, as all the publications of the Institution are, and most excellently and abundantly illustrated.

PHENOLOGICAL OBSERVATIONS ON PLANTS.—Dr. E. Vanderlinden has published (Recueil de l'Institut botanique Léo Errera, t. x.) further results of his observations on the relation between the time of flowering and various climatic conditions. He has now observed a series of woody plants during the years 1896–1920, and of herbaceous plants from 1910 to 1920. The results are tabulated and also plotted in relation to external factors, such as maximum and minimum temperature, soil temperature, and hours of sunlight. Dr. Vanderlinden finds that advancement or retardation of the flowering period in favourable or unfavourable seasons is much less in the case of herbaceous than in those of woody plants. This difference he attributes to the fact that in the latter the reserve materials accumulated to supply the new flowers occur in the aerial parts of the plant and are more exposed to the influence of atmospheric variations. Both woody and herbaceous plants show a periodicity in the distance between the two extreme dates of flowering. These are considerable in April but decrease onwards, reaching a minimum towards the end of June, and then show a progressive increase. That is to say, the flowering periods of the last half of May and the whole of June are less affected by climatic variations. The chief factor in inducing this periodicity is the less prevalence of inhibiting temperatures during the summer months as compared with the spring. The observations were made at Uccle in Belgium.

THE CONDITION OF THE EARTH'S INTERIOR.—The criticism by Mr. W. F. Jones of Prof. T. C. Chamberlin's views as to the planetesimal origin of the earth has been mentioned in a letter published in NATURE (August 19, 1922, p. 240), and it is only fair to state that Prof. Chamberlin has published a reasoned reply to Mr. Jones in the *American Journal of Science*, vol. 204, p. 253, October 1922). He maintains that the evidence as to the propagation of earthquake-waves, which originate "within the shell not very far below the surface," is entirely opposed to any theory of the existence of a molten interior in the earth at the present day, while the conception that such an interior might have arisen by condensation of solid particles in the past is incompatible with the planetesimal hypothesis. He has probably not yet had time to consider J. Joly's startling suggestion that changes within the earth may give rise to bursts of radioactivity, and that these may bring about the complete melting of a previously solid earth. Chamberlin remarks that the proofs given by Coleman and others of the batholitic nature of the granite that invades the outer and ancient sedimentary crust are destructive of the idea of an underlying crust of light material, such as might have gathered round a molten globe. To many this argument will not appear entirely sound. The occurrence of batholites forming intrusive gneisses over very wide and separated areas seems to imply the existence of a crustal layer of granitic composition from which they have ascended as remelted representatives.

WEATHER IN THE PHILIPPINES.—Hourly meteorological observations made at the Central Observatory of Manila during the calendar year 1919, prepared under the supervision of Rev. José Algué, S.J., Director of the Weather Bureau, have recently been received. Hourly readings are given of barometer, temperature, humidity, and wind velocity. During the year nine typhoons visited the Philippine Islands, and in all there were twenty-five depressions or typhoons throughout the Far East. These were all observed from June to December, no typhoons occurring from January to May. The Manila rainfall broke all records since the formation of the Observatory in 1865, both as to the monthly and annual amount. In August the total fall was 78·09 in.; the previous maximum fall in any month was 57·88 in. in September 1867. In the whole year the total rainfall at Manila was 154·39 in., almost double the normal annual fall; the greatest previous record in any year was 117·27 in. in 1867. The lower parts of the city of Manila and of several provinces of the western part of central Luzon were flooded from the end of July until about the middle of September. During the first part of the year the weather had been rather dry throughout the Archipelago. Extraordinary seismic activity occurred during the year. There were 151 earthquakes felt within the limits of the Archipelago; only two shocks, on April 28 and August 14, were of destructive character. In the Central Observatory, Manila, the seismographs recorded 420 disturbances due to insular and distant earthquakes. At Butuan the seismic disturbances numbered 1076.

ULTRA-VIOLET PHOTOGRAPHY OF OLD MANUSCRIPTS.—In a paper by Prof. The Svedberg and Hugo Andersson, which has just been published in the *Photographic Journal* (No. 63, 1923, pp. 30-32), a very instructive example is given of the use of ultra-violet light in photographing old manuscripts. When a palimpsest is illuminated with intense ultra-violet light it is found that those parts of the parchment where the old, and subsequently erased, writing was, have lost the power of strong fluorescence which is

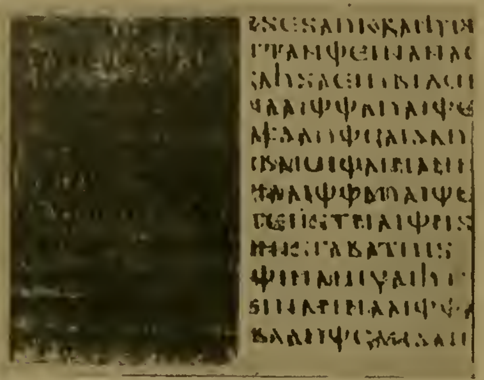

FIG. 1.

still exhibited by the untouched parts of the parchment. Kögel, in 1915, worked out this method for deciphering such parchments, and Svedberg and Nordlund used it later for deciphering the famous "Codex Argenteus" in the University Library of Upsala, and for other similar purposes. The difficulties attaching to this method lie in the very long exposures necessary to obtain a negative by means of the comparatively feeble fluorescence, several hours' exposure being necessary through the filters used to cut off the visible light from a quartz mercury lamp. The Wratten department of the Kodak Company has recently put a new U.V. filter on the market, and by means of this filter, Prof. Svedberg and Mr. Andersson have succeeded in cutting down the exposure to 15 minutes, with the results illustrated in Fig. 1, which shows the comparison between an ordinary photograph and the fluorescence photograph. The Wratten filter is superior to the Zeiss U.V. filter hitherto used for such purposes, in that it is much more transparent (about 10 times) in the long-wave part of the ultra-violet (391-344 $\mu\mu$).

THE FADING OF COLOURS.—An interesting problem, the fading of colours of objects in museums when exposed to light, was dealt with in a paper read by Sir Sidney Harmer, Director of the Natural History Departments of the British Museum, before the Royal Society of Arts on December 13. It is common knowledge that many colours fade when exposed to strong sunlight, but the relative injuriousness of diffused daylight and artificial illuminants is less known. Experiments by Dr. Russell and Sir William Abney led to the following main conclusions: (1) fading is due to the action of light and not to moderate heat; (2) it does not take place *in vacuo*, *i.e.* in the absence of oxygen and moisture; and (3) the rays of the violet end of the spectrum produce the greatest amount of fading. Experiments with various glasses devised to check the transmission of ultra-violet rays have been made. Some of these have a useful effect, but it appears that in general the use of tinted glasses merely delays fading and does not prevent it, in the case of fugitive colours. The best glass for the purpose had a distinct yellow coloration, rendering its use for cases scarcely practicable. As examples of the length of continuous exposure necessary to cause fading it is mentioned that the wings of certain moths showed appreciable fading in 10-21 days; on the other hand, the fur of the tiger required 175 days, and of a brown horse and antelope 1485 days, before there was perceptible change of colour. According to these experiments direct sunlight was about from 20 to 70 times as injurious as electric light, and diffused daylight about six times as injurious. While too much importance should not be attached to such figures, there seems little doubt that illumination by electric light is less liable to cause fading than natural light, and the question arises whether very valuable specimens, or those with highly fugitive colours, might not be lighted entirely by artificial means. Most artificial illuminants contain less ultra-violet energy than daylight. But apart from this it is possible that a much lower intensity of illumination might suffice to enable specimens to be seen.

STANDARDISATION OF EXPERIMENTAL TANK DATA.—In view of the fact that nearly all the important maritime nations of the world have experimental tanks, the introduction of international systems for the presentation of results would be extremely helpful to experimenters and designers. Mr. Telfer, in a paper, "The Presentation of Ship Model Experiment Data," read before the North-East Coast Institution of Engineers and Shipbuilders, on December 8, discusses the existing systems of presentation and their relative usefulness. He points out that the basis of any system should be dimensionless, and that the units forming this basis should be international, besides giving results finally that can be readily interpreted by practical men without any arithmetical unravelling. Experimental work up to the present has been presented in widely different forms. Froude used expressions Speed/(Vol.)$^{\frac{1}{6}}$ and Power/(Vol.)$^{\frac{2}{3}}$(Speed)^3, giving results for a one cubic foot model. Taylor, on the other hand, expresses his results per ton of displacement. Mr. Telfer suggests that results could be made international by adoption of the metric system and presenting results for models of one metric ton displacement, adopting Power/(Volume)$^{\frac{7}{6}}$ and Speed/(Volume)$^{\frac{1}{6}}$ as the basis of the presentation. He also suggests the adoption of definite symbols, these being selected "from international philological considerations, all related symbols being mnemonically appropriate and above all typographically simple rather than typographically unique." Such an international code is greatly needed. There is at present an awkward disregard for standardisation of symbols even among experimenters of the same nation. It is to be hoped that this present paper will help forward in ship model data what has already been adopted in aeronautical work. Before setting up an international system such as is suggested, it would be best for a representative committee to inquire into the basis to be adopted, and also to undertake the transference into this system of all existing data.

The Distribution of Life in the Southern Hemisphere, and its Bearing on Wegener's Hypothesis.

ONE of the most important results of the acceptance of Wegener's theory of the palæogeography of the world would be the simplification of the facts of the Permo-Carboniferous glaciation of Australia, India, South Africa, and South America by bringing the glaciated areas together into one single glaciated region. It is undoubted that if this were done much of the difficulty of accounting for the simultaneous glaciation of regions so diverse in latitude would disappear. Considerable interest, therefore, attaches to the recent discussion on Wegener's hypothesis, which was held before the Royal Society of South Africa, for its bearing on this important aspect of the subject.

The general attitude of the geologists who took part in the discussion was one of suspended judgment. It is admitted that the folded ranges of the Sierras of Buenos Aires appear to be of similar age and structure to those of the southern folded belt of the Cape Province, and would be brought into fairly accurate alignment if the South American coast were fitted into the African coast after the manner of Wegener's map of Carboniferous land distribution, but it was held that this might be accounted for in several other ways more in accord with the known facts of geology. On the other hand, the very close and detailed homology of the Tertiary deposits of Grahamland and Patagonia as described by Gunnar Andersson forms one of the most relevant pieces of combined geological and palæontological evidence from the southern hemisphere in support of the theory.

Discussing the zoological evidence, Mr. K. H. Barnard concludes that the zoologist, far from being able to help in formulating an explanation of the palæogeographical history of the continents, was, in reality, entirely dependent on the geophysicist and geologist, and that in some cases the facts of present-day distribution were capable of interpretation in terms either of a far-reaching equatorial Gondwanaland or a compact polar Gondwanaland. There is little to choose, for example, between Watson's theory of the dispersal of acarid snails from S.E. Asia [equatorial Gondwanaland] and Hedley's theory of their origin in Antarctica [polar Gondwanaland], and whichever geological theory best explains the palæogeographical changes must be used as a basis by zoologists. Similarly, if the ancestors of the freshwater crayfishes originated in an arm of the Indo-Pacific which gradually penetrated into polar Gondwanaland in pre-Jurassic times, the same results will follow as those sketched out by Ortmann for post-Jurassic times. The distribution of Peripatus, on the other hand, is apparently best explained on the polar Gondwanaland hypothesis. If the distribution of the species of Peripatus is plotted on a polar projection map, it is remarkable that the Peripatopsidæ, the more specialised group, occupy a central position, while the Peripatidæ, the more primitive, are peripheral. The most important zoological evidence in support of Wegener's theory is provided by the isopod, Phreatoicus. At the present time it is found in Australia, Tasmania, New Zealand, and South Africa. There is the closest possible likeness between some of the Australian species and the Cape form. In Australia there is also a fossil species of Triassic age, which provides almost positive proof that the animal was not only palæogenic, but also austrogenic, and that the regions where it exists to-day were once in the very closest relationship to one another.

Dr. Peringuey, discussing the entomological evidence, concludes that the present distribution of insects is as readily accounted for by the geological theories now obtaining as by Wegener's hypothesis, and believes that the latter will receive little if any support from entomology. He agrees that the key will be found in palæo-entomology, but is forced to admit that the evidence from fossil insects is at present too inadequate to be of value. Discussing the special case of the Coleopteron genus Carabus, first found in Jurassic times, Dr. Peringuey points out that it is unknown in the Old World south of the Sahara, but one species occurs in St. Helena and seven in Chile. He regards the St. Helena and Chilian forms as survivals from an equatorial Gondwanaland, in isolated spots at high altitudes, and not as evidence of the former connexion of South America and St. Helena, in their present form, with South Africa, where the genus is absent, or with Australia, where the genus is unknown but where its vitality should have ensured its success. On the other hand, the nearest ally of Carabus, the genus Calosoma, has three species in South Africa, three in Australia, one in the Galapagos Islands, and one in Patagonia, a distribution which seems to support the unity of the continents alleged by Wegener. In Australia there is a group of large Curculionidæ, one of the families of Coleoptera, which so much resembles a purely South African group of the same family that, at first sight, the two might be taken to represent the same stock in two now widely separated continents. Dr. Peringuey, however, regards this as a case of convergence.

Prof. Compton regards the botanical evidence as completely opposed to Wegener's theory. The perfection of the means of dispersal of plants renders many of the facts as to the modern distribution of ancient groups (Cryptogams) almost valueless as an indication of former land connexions. Recent phyla only, especially the Angiosperms, can be relied on. The Angiosperms arose during Cretaceous times, and most modern families are represented in the Eocene. The Wegener hypothesis contemplates a wide disruption of South Africa and Australia in the Jurassic epoch, but South Africa and South America were only separated by a very narrow strait at the end of the Cretaceous period. Yet the floristic resemblances between temperate South Africa and South America are much less conspicuous than between temperate South Africa and Australia. The floristic relationships between South Africa, South America, and Australia are best explained as being due to lateral migration, perhaps in the warmer Miocene, from a comprehensive tropical belt of vegetation, containing most of the great Angiosperm families, which stretched round the world except the Pacific. The south temperate floras, therefore, are linked through the tropics except for South America and New Zealand, which certainly seem to have been connected by land, via Antarctica, in the Miocene. The modern distribution of the Rutaceæ is an excellent instance of the progress of migration southwards as well as northwards from this tropical belt, and tentative explanations of the distribution of the Proteaceæ and Restionaceæ may be given on the same lines. Dr. Du Toit regards the palæobotanical evidence as too fragmentary for botanists to do more than make guesses at the probable origin of the South African flora.

The net result of this interesting discussion is to emphasise the importance of further work on the palæontology of the southern hemisphere. In that direction alone will be found the key to the correct interpretation of the known facts of the present day distribution of animals and plants, and of the palæogeographical changes which have taken place.

The Position of the Scientific Worker.

AT the annual council meeting of the National Union of Scientific Workers, held at the Caxton Hall, Westminster, on January 13, and at the annual dinner which followed, the main theme of the resolutions which were adopted, of the various speeches made, and of the reports presented, was the methods by which the position of the scientific worker could best be improved. The late Government, it was alleged, had adopted a short-sighted policy with regard to most of those State activities which promised to have the most uplifting and far-reaching effect upon the efficiency and well-being of the nation. It had practised so-called economy by reducing expenditure on education and scientific research, at a time when our chief commercial rivals were increasing their expenditure in that direction.

To the want of appreciation and understanding of the importance of science by the members of the late Government, culminating in drastic reductions in the various research departments, were attributed most of the present troubles of scientific workers. Within the past twelve months "economies" have been effected in those departments of the State and municipal services which do not show an immediate return for the money expended. The inevitable effect will be stagnation in peace, and in war hurried, and therefore uneconomical, research. It is true that the Geddes Committee last year expressed the view that there is little possibility of a further war of any magnitude for the next ten years; but just as their prognostications in that respect appear doubtful at the moment, judged by the trend of current events, so is their corollary to the effect that research in this country can either be slowed down, or, in some instances, abandoned altogether. This is a doctrine of despair, and was characterised as such by members of the council of the Union, and by their guests, Sir Thomas Holland, Mr. William Graham, and Mr. H. N. Brailsford.

Mr. Graham said that there were three aspects of the work of the National Union of Scientific Workers which particularly interested him. The Union must be interested in conditions of employment and remuneration, and he felt that it was a serious mistake, if not a positive crime on the part of the community, to starve the body of investigators upon whose efforts so much depends. The Union would also be alive to the importance of according greater recognition to the work of the universities, and to the contribution that science can make to the restoration of economic prosperity in the world. He thought there was a distinct danger to the universities in the present economy campaign. Before the war the country was making only a limited provision for the universities and other educational institutions. As a member of the Oxford and Cambridge Universities Commission, he had had an opportunity of making a careful examination of university departments and university finance, and he hoped that the Bill to be presented to Parliament next session would result in the present grant being more than trebled. It would not do to rely in the future, as in the past, on philanthropy. Much larger sums of public money would be required, and scientific workers could argue strongly that they did not claim it selfishly, but for the benefit conferred on the nation by their investigations. The methods of science are needed in these days of reconstruction, and if adopted would undoubtedly increase production and help in resisting the lowering of the standard of life, which is a pressing danger in every country. Sir Thomas Holland fully endorsed these views, adding that the Government should understand that at least 80 per cent. of the expenditure of a teaching and research institution must be disbursed as salaries to the staffs. A strong and united body of scientific workers is a necessity if salaries are to be improved and the right atmosphere created. Unfortunately the dignity of the work in most people's eyes is apt to be commensurate with the sums paid for it, so there is every reason why the Union should put the question of remuneration in the forefront.

Dr. Alan A. Griffith, the retiring president, in his address, dealt with this matter from a rather different point of view. He suggested that scientific workers should free themselves from the necessity of having to beg from their beneficiaries the wherewithal to improve the efficiency of their labours, by setting up a business organisation for the exploitation of their discoveries and inventions. In providing specifically for the evolution of great inventions based on pure research, it would fill the gap between science and industry, which has, in the past, so seriously hampered the material utilisation of scientific discoveries.

The Hydrogen-ion Concentration of Sea Water.

A RECENT number of the Journal of the Marine Biological Association (vol. xii., No. 4, October 1922) contains a series of papers by Dr. W. R. G. Atkins which make a contribution of conspicuous value towards our knowledge of the fundamental conditions that control vital production in the sea. After a short review of the literature the author considers what lines of research his study indicates, and then follow six memoirs which deal, in the most interesting way possible, with some of the problems that have suggested themselves.

First in importance is a series of determinations of the H-ion concentration in the open sea between Plymouth and Ushant, and round Land's End into the mouth of the Bristol Channel. In the open sea the "*p*H" values varied between 8·27 and 8·14; round Land's End the variation was between 8·18 and 8·14, and in Plymouth Sound it was about 8·10. Now "*p*H" means the logarithm of the reciprocal of H-ion concentration expressed in grams per litre of water. High values (up to about 10) mean high values of the "alkalinity" as represented, for example, by the quantity of N/100 acid necessary to decolorise sea water made pink by the addition of phenolphthalein. Low values (down to about 6) mean "acidity" of the sea water by reason of the presence of unusually large quantities of carbonic acid.

Biological relationships are associated with these variations in the *p*H-values. Thus, there is a decrease of about 0·05 between high and low water, and this is due to the influence of the water draining away from the shore zones; over a bed of Laminaria the water was more alkaline than in the immediate neighbourhood, and in rock pools *p*H sank by as much as 0·25: this is the result of photosynthesis by algæ which remove carbonic acid. In the aquarium tanks the *p*H-values sink to 7·6. When it is less than this, carbon dioxide is in excess, and at 7·3 there is evident distress in the respiration of fishes. At 7·1 the water becomes foul and smells badly, and at 6·4 we have the conditions produced by seaweeds rotting in a jar of water. From the change in pH-values the quantity of carbon removed from solution in the sea in the form of carbon dioxide, and built up, by photosynthesis, into the tissues of marine plants, can be calculated. Represented as a hexose, the author gets the surprisingly great production of 250,000 kilograms produced per square kilometre of sea, in the English Channel between July and December. From similar observations made at Port Erin, Moore found a production of 300,000 kilograms per square kilometre during the six months that included the vernal maximum of diatom reproduction.

The other researches are equally important, especially as they deal with methods. The practice of determining organic matter by oxygen consumed in water samples is criticised. The reaction of the sap in the cells of marine algæ has been studied: it is shown to be almost neutral, in contrast with the acid sap of most land plants. Methods of finding the H-ion concentration in living algal cells are developed, and the influence of changes in pH is shown to be a factor in the distribution of shore weeds. Finally—a most useful result—the preparation of permanently acid-free formalin solutions is described. This series of papers by Dr. Atkins has particular interest for marine biologists. J. J.

The Structure of Coke.

Sir George Beilby has contributed an interesting paper entitled "The Structure of Coke, its Origin and Development," to the Transactions of the Society of Chemical Industry (November 15, 1922). The paper contains a critical discussion of the changes that have been observed in coal and similar substances during the process of carbonisation, and an account of experimental work carried out on the micro-structure of coke and charcoal.

Use has been made of the new knowledge concerning solids and their internal constitution, for which Sir William Bragg is so largely responsible; and, in another direction, of the technique for cutting and studying sections of coal, introduced by Mr. Lomax. A number of specimens for examination were photographed at their natural size, and with different magnifications and illuminations. It was observed how very much the structure of coke was determined by the size of the bubbles blown in the viscous mass during the semi-liquid stages of carbonisation, and even what have hitherto been commonly regarded as the solid vitreous cell-walls of the pores have been shown to be permeated by minute bubbles. Bound up with this is the control of the bubble formation which can be effected by blending coals of different behaviour, and the practical possibilities forthcoming in this way are discussed at some length. It is shown, for example, that the blending of a coal which swells and froths inordinately with another coal of the non-caking variety may be utilised for securing a strong and firm coke with small and evenly distributed pores.

The relevance of work by Messrs. Sutcliffe and Evans on the briquetting of pulverised coals as a preliminary to carbonisation is indicated. It has been claimed by them that the control of structure could be extended almost indefinitely by the briquetting of finely ground coal by pressure as a preliminary to carbonisation. It was by working along such lines that Sutcliffe and Evans were able to produce a material stated to have at least three times the gas-absorbing capacity of the best wood charcoal, and specially suitable for use in gas masks. Sir George Beilby points out that the combustion of these close-grained "pressure" briquettes proceeds definitely from the outer surfaces inwards, showing that the internal circulation of the oxidising gases is much more restricted than in the case of metallurgical coke — which raises an interesting question.

Seventeen figures are used to elucidate the argument of the text. They are all photo-micrographs of coke produced commercially in gas retorts, coke ovens, etc., or in the laboratory under special and controlled conditions. J. W. C.

University and Educational Intelligence.

Aberdeen.—The Thomson Lecturer for 1923 at the Aberdeen United Free Church College is Prof. J. Arthur Thomson, LL.D., whose subject is "What is Man? The Nature of Man Scientifically Considered."

Edinburgh.—Mr. G. G. Chisholm, reader in geography, is to retire at the end of September next, in consequence of which the University Court will shortly proceed to appoint a lecturer who will be responsible for, and in charge of, the teaching of geography in the University. The status of reader may be attached to the office. Applications for the post must reach the Secretary by, at latest, February 28.

The late Mr. C. T. Milburn, of Newcastle-on-Tyne, bequeathed the sum of 10,000*l.* (in addition to 20,000*l.* given in his lifetime) to Armstrong College, expressing a wish that the legacy should be used for the endowment of a chair for the education of mining engineers or of naval architects, and that his name should be associated with it.

The annual prize distribution at the Sir John Cass Technical Institute, Aldgate, E.C.3, will be held on Wednesday, January 31, when Sir Thomas Holland, after making the presentations, will deliver an address on "Humanism in Technical Education."

Messrs. Norton and Gregory, Ltd., offer two engineering scholarships to be competed for annually, one of value 100*l.* per annum, and one of value 50*l.* per annum, tenable for three years at any university in the United Kingdom or British Dominions. The honorary committee which will award the scholarships consists of Sir Joseph Petavel (Chairman), Prof. C. E. Inglis (Vice-Chairman), Prof. E. G. Coker, Mr. J. Talbot, Mr. G. H. Burkhardt, and the Chairman and Managing Director of Messrs. Norton and Gregory, Ltd. Candidates must have reached the age of 17 but not the age of 19 on March 1 in the year of examination, be domiciled in the United Kingdom, and undertake to pursue a three years' course in engineering with the view of following it as a profession. Papers, which will cover two days' examination, will be set in English, mathematics, mechanics, and general physics. The main object of the examination will be to prove that candidates have received a good general education on broad lines and not necessarily specialised in engineering. The examination for the 1923 scholarships will be held in March at a date to be fixed later, and all application forms must reach the committee not later than February 15. Official application forms may be obtained from the Secretary, Scholarships Committee, Messrs. Norton and Gregory, Ltd., 1 and 2 Castle Lane, Westminster, London, S.W.1.

Societies and Academies.

London.

The Royal Society, January 18.—Sir Charles Sherrington, president, in the chair.—J. **Barcroft**: Observations on the effect of high altitude on the physiological processes of the human body. Three principal factors appear to have a positive influence in acclimatisation. (*a*) The increase in total ventilation, which usually raises the alveolar oxygen pressure ten or twelve millimetres higher than it would otherwise be; (*b*) The rise in the oxygen dissociation curve so that at any oxygen pressure the hæmoglobin will take up more oxygen than before; (*c*) The rise in the number of red corpuscles, and correspondingly in the quantity of hæmoglobin. These factors are not independent variables. Blood has been found to give, at the alveolar carbon dioxide pressure of the Andes (about 27 mm. carbon dioxide): (1) A reaction which is apparently almost unchanged, or even more acid, as measured by the ratio of combined to free carbon dioxide; (2) A more alkaline reaction by the platinum electrode; (3) An oxygen dissociation curve which rises apparently out of proportion to the change in reaction. On making the ascent, there was a marked increase in the number of reticulated red cells; after the descent these cells fell to below their normal percentage. In the natives the ratio of reticulated to unreticulated red cells was not greatly increased, but the absolute number of reticulated cells per cubic millimetre was about 50 per cent. greater than normal. We argue a hypertrophy in the bone marrow. There were no nucleated red cells. The increase in red blood corpuscles is such as to cause an absolute increase in the amount of oxygen in each cubic centimetre of blood in the majority of cases, in spite of the decrease in saturation. A number of mental tests of the ordinary type were performed at Cerro and at sea-level. These revealed no particular mental disability. The pressure of oxygen in the blood was so nearly the same as that in the alveolar air that we attribute the passage of gas through the pulmonary epithelium to diffusion.—E. W. **MacBride**: Remarks on the inheritance of acquired characters. During the last fifteen or twenty years a series of experiments have been carried out by Dr. Paul Kammerer at Vienna, which tend to show that acquired qualities, or, in other words, modifications of structure induced by modified habits, are inheritable. One of the most interesting of his experiments was to induce Alytes, a toad which normally breeds on land, to breed in water. As a result, after two generations, the male Alytes developed a horny pad on the hand, to enable him to grasp his slippery partner. Mr. J. Quastel, of Trinity College, Cambridge, when in Vienna, saw and photographed one of these modified males; the animal has also been seen by Mr. E. Boulenger.—C. F. **Cooper**: *Baluchitherium osborni* (? syn. *Indricotherium turgaicum*, Borrissyak). *Baluchitherium osborni* is an aberrant rhinoceros, apparently the largest known land mammal. The remains were first found in Baluchistan. Further fragments have been found in Turkestan, and, recently, in China. While resembling the rhinoceroses more than any other of the Perissodactyla, Baluchitherium is still isolated and of uncertain zoological position. Adaptations to weight have brought about a superficial resemblance to the limb bones of elephants. Some of the foot bones and neck vertebræ resemble those of the horse; due possibly to descent from a small eocene form, Triplopus, which likewise shows an intermingling of horse and rhinoceros characters. In some structures, notably the excavations of the vertebral canal to ensure a combination of lightness and strength, Baluchitherium stands alone among mammals.—J. A. **Gunn** and K. J. **Franklin**: The sympathetic innervation of the vagina.—H. G. **Cannon**: On the metabolic gradient of the frog's egg.—Basiswar **Sen**: On the relation between permeability variation and plant movements.—H. L. **Duke**: An inquiry into an outbreak of human trypanosomiasis in a *Glossina morsitans* belt to the East of Mwanza, Tanganyika Territory.—Louis **Dollo**: Le Centenaire des Iguanodons (1822–1922).

Geological Society, December 20.—Prof. A. C. Seward, president, in the chair.—W. A. **Richardson**: A micrometric study of the St. Austell granite (Cornwall). The problem of the effect of sampling a coarse-grained rock by means of slices is considered in detail. Qualitative and quantitative study of the minerals reveals three types of rock: (*a*) a biotite-muscovite-granite of coarse grain confined to the east: (*b*) a lithionite-granite occupying by far the greater part of the outcrop; and (*c*) a gilbertite-granite confined to a small area near St. Stephen's Beacon, and furnishing the "china-stone" rock. A high negative correlation is found between quartz and orthoclase—true for this area, but not for granites in general. When mapped, the minerals fall into groups that are distinctly connected with the areas occupied by the different types, and in each of which there is an outer zone rich in quartz surrounding an inner region with a high content of orthoclase. The magma probably invaded the area progressively from the east to the west; it had always partly crystallised before injection into the present level.—W. G. St. J. **Shannon**: The petrography and correlation of the igneous rocks of the Torquay promontory. Two stages of vulcanicity occurred—in the Middle and in the Upper Devonian, as shown by basic tuffs and a spilite. The intrusions form an alkaline suite. An augite-lamprophyre in limestone, and a soda-porphyrite in Middle Devonian slates are described from Babbacombe. A preliminary account of the tectonics is attempted, particularly of the inversion, at Ilsham, of the faulting and of the north-to-south strike of some of the folds.

Aristotelian Society, January 8.—Prof. T. P. Nunn in the chair.—W. Adams **Brown**: The problem of classification in religion. The differences in existing religions may be explained in three different ways. They may be regarded, as variations from a single standard type; as moments in the development of one all-embracing religion; or as recurrent parallel contrasted types. If the last view be taken, the principle of classification may be found in the variations of the individual personal experience, or in differences in man's social attitude. Most recent study of religious types has followed the first of these methods. This method, helpful so far as it goes, can be usefully supplemented by an analysis of man's social relationships. The new classification is based upon the attitude of religious people to social institutions. There are three possible attitudes which one may take towards the existing social order. One may accept it as it is without question and yield its institutions willing and loyal allegiance. One may protest against it as corrupt or negligible and find in one's own inner life a sufficient refuge and compensation. One may believe that society is itself in process of being transformed into new and better forms and that each man and woman may have part in that remaking. These three attitudes have their counterpart in religion. One man believes that he communes with God most perfectly through allegiance to some existing organisation the triumph of which in the world he identifies with the victory of God's will. Another believes that he communes with God most deeply when he withdraws his attention from all that is finite and transitory, and concentrates it upon the attempt to realise the immediate presence of God. A third is persuaded that he communes with God most truly as he joins his fellows in remaking the institutions of society (including the church itself) according to a constantly clearer apprehension of the will of God, as that will is being progressively revealed to all who seek it in humility and faith. These three types may be designated imperialism, individualism, and democracy. Each has given rise to institutions appropriate to its genius.

Mineralogical Society, January 9.—Dr. A. E. H. Tutton, past-president, in the chair.—A. **Brammall** and H. F. **Harwood**: Dartmoor occurrences of (1) rutile, brookite, and anatase; (2) zircon. (1) Anatase, with less abundant brookite and scanty rutile, is common in Dartmoor stream-sands, etc. Anatase and brookite, absent from the unaltered grey granite, have been found in pneumatolysed rocks, especially "red" granites, and the mode of genesis of these two minerals is discussed. Data provided by chemical work on "baueritised" Dartmoor biotite (containing about 1·8 per cent. TiO_2) and by the occurrence of anatase granules encrusting detrital grains of ilmenite are examined in their bearing on the possibility that some anatase may have developed (or existing crystals may have continued to grow) in detrital material after sedimentation. (2) Two strongly contrasted kinds of zircon crystals are described: differences in crystal habit, nature of inclusions, and mode of occurrence in the granite suggest that the dominant kind, which is tawny, zoned, and rich in inclusions, crystallised out from the magma early, and that the subordinate kind, water-clear, and containing few inclusions, separated out at a much later stage.—Dr. L. J. **Spencer**, with chemical analyses by E. D. **Mountain** and microscopical determinations of the pseudomorphs by W. Campbell **Smith**: A davyne-like mineral and its pseudomorphs from St. John's Island, Egypt. Two small crystals found with peridot, garnierite, etc., showed the physical characters of davyne, but consist of a complex silicate (with sulphate and carbonate) of aluminium, calcium, magnesium, and sodium, together with a considerable amount of water. Pseudomorphs after this material are more abundant; they consist of a complex of hydrated silicates of aluminium and magnesium together with small amounts of corundum and spinel.

Royal Meteorological Society, January 17.—Dr. C. Chree, president, in the chair.—C. **Chree**: Aurora and allied phenomena. Brilliant aurora in England seems always to be accompanied by a magnetic storm, and any outstanding magnetic disturbance is accompanied by aurora. Thus presumably they have a common cause, now generally believed to be electrical currents in the upper atmosphere, originated by a discharge of some kind from the sun. Our knowledge of the height of aurora is mainly due to Norwegian men of science. Prof. Carl Störmer discovered how to photograph aurora, and by taking simultaneous photographs from the ends of a long base, and measuring the apparent parallax, he is able to calculate the height. For the lower level of aurora he finds heights in the neighbourhood of 100 kilometres. The height of the highest visible appearance varies greatly. Heights exceeding 300 kilometres are not very uncommon, and some measurements have exceeded 600 kilometres. Travelling northwards from the south of England, aurora and magnetic disturbances both increase, the former at least very rapidly. The auroral frequency in Shetland is said to be 10 to 20 times that in the extreme south of England. There is thus within the British Isles a great variety in the frequency or intensity of aurora, and it is also believed in the intensity of magnetic disturbance. An observatory provided with magnetographs has recently been established in Shetland, and if adequate means are forthcoming for the intensive study of auroral and magnetic phenomena, substantial contributions to knowledge may reasonably be expected.

Paris.

Academy of Sciences, January 3.—M. Albin Haller in the chair. The president announced the death of Gaston Bonnier, member of the section of botany.—R. de **Forcrand**: The alcoholates of thallium. Thallium differs from sodium and potassium in that it does not displace hydrogen directly from the alcohols. Alcohol vapour acts upon thallium in the presence of oxygen, giving the compound $C_2H_5 . OTl$ as a dense oily liquid (density 3·55). This liquid added to an excess of anhydrous methyl alcohol gives thallium methylate, $CH_3 . OTl$, as a solid. With the same thallium ethylate as the starting point, corresponding compounds have been prepared from glycol, glycerol, and phenol.—Paul **Vuillemin**: The classification of the monocotyledons.—Bertrand **Gambier**: The curves of Bertrand.—Stanislas **Millot**: Probability *a posteriori*.—J. **Haag**: The study of certain problems in kinetic theory, with the hypothesis that the intermolecular force is some function of the distance.—Margaret G. **Tomkinson**: The catalytic hydrogenation of sulphur dioxide. A mixture of dry hydrogen and sulphur dioxide in the presence of reduced nickel at about 400° C. gives water, sulphuretted hydrogen, and sulphur. The nickel is wholly converted into nickel sulphide, but in spite of this, the catalytic reduction can be carried on indefinitely.—A. **Mailhe**: The catalytic decomposition of castor oil. The oil was decomposed by passing over alumina and metallic copper at 550° to 570° C. The gaseous products contained 36 per cent. of unsaturated hydrocarbons: from the liquid portion oenanthylic aldehyde, hexane, and heptane were isolated. At temperatures above 600° C. aromatic hydrocarbons were also identified.—Mme. A. **Hee**: Study of the Algerian earthquake of August 25, 1922, from the microseismic observations. A discussion of the seismographs from eight observatories. The epicentre was deduced from these to be near Cavaignac, and this is in agreement with the macroseismic observations.—Emmanuel **de Martonne**: The Pliocene delta of the Var and the erosion levels of the valleys opening into it.

Sydney.

Linnean Society of New South Wales, November 29.—Mr. G. A. Waterhouse, president, in the chair.—J. **Mitchell**: Descriptions of two new trilobites and note on *Griffithides convexicaudatus* Mitch. A species of Cordania is described from Australia for the first time. A new species of Ptychoparia forms an addition to the fossil fauna of North-west Queensland. *Griffithides convexicaudatus* Mitchell is transferred to the genus Phillipsia.—Marguerite **Henry**: A monograph of the freshwater Entomostraca of New South Wales. Pt. ii. Copepoda. Twenty-three species of copepods, one of which is recorded for the first time in Australia, four for the first time in New South Wales and three which are new, are described. Two of these species belong to the division Harpacticoida.—C. P. **Alexander**: New or little known species of Australian Tipulidæ (Diptera), Pt. i. An account of twenty-three specimens from a number of Australian collections.—H. S. Halcro **Wardlaw**: The effect of suspended respiration on the composition of alveolar air. Inspirations were held in the lungs until the composition of the alveolar air ceased to alter. Circulatory disturbances were minimised by holding an inspiration for a number of consecutive short periods instead of for one long period. Similar final values were reached whether the initial inspiration consisted of air alone or of air mixed with a percentage of carbon dioxide higher than the normal alveolar percentage. Similar final values were reached also whether the inspiration was held under normal or under negative intrathoracic pressure; this was not the case when circulatory disturbances were allowed to exert their effect.—A. M. **Lea**: On Australian Anthicidæ (Coleoptera). Notes on synonymy, variation, and distribution are given, and 53 species are described as new.—J. **McLuckie**: A contribution to the parasitism of *Notothixos incanus* (Oliv.) var. *subaureus*. The structure of the fruit, the mechanism of seed-dispersal, the structure of the haustorium and its relation to the host-tissues, are described.—T. Thomson **Flynn**: The phylogenetic significance of the marsupial allantoplacenta. In a typical mammal, the placental cycle is divisible into three stages,—metrioplacental, omphaloplacental, and allantoplacental. The last stage is absent in all marsupials except Perameles. Examination of the allantoplacenta of Perameles shows its definite relation to that of Monodelphia. It is considered that the ancestors of marsupials were, therefore, placental.

Official Publications Received.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. New Series, No. 14, January. Edited by W. F. Spear. Pp. 186. (London: Gt. George Street.)

Agricultural Research Institute, Pusa. Bulletin No. 136: The Hydrogen Ion Concentrations of some Indian Soils and Plant Juices. By Dr. W. R. G. Atkins. Pp. ii+12. Bulletin No. 137: Note on the Probability of an Inter-relation between the Length of the Stigma and that of the Fibre in some forms of the genus Gossypium. By Ram Prasad. Pp. ii+7+2 plates. (Calcutta: Government Publications Office.) 4 annas each.

Schriften der Naturforschenden Gesellschaft in Danzig. Neue Folge. Fünfzehnten Bandes Drittes und Viertes Heft. Teil 2: Jahresbericht fur 1921. Pp. ii+55. Teil 3: Wissenschaftliche Abhandlungen. Pp. viii+112. (Danzig).

44 Bericht des Westpreussischen Botanisch-Zoologischen Vereins. Pp. iv+30. (Danzig).

Geological Literature added to the Geological Society's Library during the Year ended December 31st, 1914. Compiled by Arthur Greig. Pp. iv+193. (London: Geological Society.) 5s.; 3s. 9d. to F.G.S.

Hampstead Scientific Society. Report of the Council and Proceedings, with a List of the Members, for the Period October 1920 to September 1922; with Reports of General Meetings, 1919-1920. Pp. 63. (London: Stanfield House, Prince Arthur Road.)

Diary of Societies.

SATURDAY, JANUARY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Walford Davies: Speech Rhythm in Vocal Music (2).

MONDAY, JANUARY 29.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College for Women), at 4.30.—L. Abercrombie: Communication *versus* Expression.
INSTITUTE OF ACTUARIES, at 5.—W. Palin Elderton: Notes on the Treatment of Extra Risk.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. R. L. Knaggs: Osteitis Fibrosa.
ROYAL SANITARY INSTITUTE, at 5.30.—Dr. L. C. Parkes: Introductory Lecture to Students in the various Courses.
ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. W. A. Brown: The Problem of Classification in Religion.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Capt. J. E. T. Phillips: Kigezi and the Birunga Range, Uganda.

TUESDAY, JANUARY 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—R. D. Oldham: The Character and Cause of Earthquakes (1).
INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—A. Keens: Some Deductions from Indicator Diagrams.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—T. Bell: On the Thames with a Camera.

WEDNESDAY, JANUARY 31.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. M. Woodman: Malignant Disease of the Upper Jaw, with special reference to Operative Technique.
INSTITUTION OF MECHANICAL ENGINEERS (Students' Meeting), at 6.—T. R. Wilton: Foundations in Dock and Harbour Works (Vernon-Harcourt Lectures) (2).
ROYAL SOCIETY OF ARTS, at 8.—T. H. Fairbrother and Dr. A. Renshaw: The Relation between Chemical and Antiseptic Action in the Coal Tar Dyes.
ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.—Prof. W. Wright: Leonardo da Vinci.

THURSDAY, FEBRUARY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. I. M. Heilbron: The Photosynthesis of Plant Products (1).
ROYAL SOCIETY, at 4.30.—Prof. O. W. Richardson: The Magnitude of the Gyromagnetic Ratio.—Sir Richard Paget: The Production of Artificial Vowel Sounds.—F. Simeon: The Carbon Arc Spectrum in the Extreme Ultra-violet.—Prof. J. Joly: Pleochroic Haloes of various Geological Ages.—Prof. H. A. Wilson: The Motion of Electrons in Gases.—Dr. H. Hartridge: The Coincidence Method for the Wave-length Measurement of Absorption Bands.—A. Berry and Lorna M. Swain: The Steady Motion of a Cylinder through Infinite Viscous Fluid.—W. Jevons: The Line Spectrum of Chlorine in the Ultra-violet (Region λ 3354-2070 A).—M. H. Evans and H. J. George: Note on the Adsorption of Gases by Solids and the Thickness of the Adsorbed Layer.
LINNEAN SOCIETY OF LONDON, at 5.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—G. S. Baker: Ten Years' Testing of Model Seaplanes.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—P. J. Robinson: The Maintenance of Voltage on a D.C. Distribution System by means of a fully Automatic Substation.
CHEMICAL SOCIETY, at 8.
ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. W. R. White-Cooper and H. K. Griffith: (1) A Case of Inversion of the Uterus occurring in the Third Week of the Puerperium; (2) A Case of Obstructed Labour due to Contraction Ring.—B. Whitehouse and Dr. H. Featherstone: Note on the Use of Spinal Anæsthesia with Tropococaine in cases of Cæsarian Section.—Dr. S. Cameron: Cæsarian Section.
CAMERA CLUB, at 8.15.—J. E. Saunders: Off the Beaten Track at the Zoo.

FRIDAY, FEBRUARY 2.

ROYAL SOCIETY OF MEDICINE, (Laryngology Section), at 4.45.—Dr. I. Moore: Operative Procedures in the Treatment of Bilateral Paralysis of the Abductor Muscles of the Larynx, with Special Reference to a New Method by means of which, it is suggested, the Air-way may be Re-opened and the Patient Decannulated.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. C. A. Joll: The Metatastic Tumours of Bone.
ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Col. E. M. Jack: The Projection for the International Aeronautical Map. Other speakers, Capt. G. T. McCaw, Col. Sir C. F. Close, Col. J. L. Winterbotham, and probably A. R. Hinks. Chairman, Sir G. P. Lenox-Conyngham.
INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—A. E. L. Chorlton: The Use of Light Alloys in place of Iron and Steel.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—P. J. Waldram: Ventilation and Lighting of Factories.
ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. R. J. Reece: Progress and Problems in Epidemiology (Presidential Address).
ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30—Dr. J. S. Goodall: Some Cardiovascular Conditions in relation to Anæsthesia.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—C. F. Cross: Fact and Phantasy in Industrial Science.

PUBLIC LECTURES.

SATURDAY, JANUARY 27.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Capt. W. H. Date: Wireless Telephony and Broadcasting.

TUESDAY, JANUARY 30.

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy. (Succeeding Lectures on January 31, February 1 and 2).

WEDNESDAY, JANUARY 31.

KING'S COLLEGE, at 5.30.—Sir Frank Dyson: The Measurement of Stellar Distances.

THURSDAY, FEBRUARY 1.

FINSBURY TECHNICAL COLLEGE (Leonard Street), at 7.30.—Sir Oliver Lodge: The Basis of Wireless Communication (Silvanus Thompson Memorial Lecture).
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—G. T. Forrest: London's Unhealthy Areas (Chadwick Lectures (1)). (Succeeding Lecture on February 8).

SATURDAY, FEBRUARY 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: Insect Pests and their Control.

NATURE

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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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Editorial communications to the Editor.

The Science and Practice of Pure Milk Supply.

II.

IN last week's article on this subject emphasis was placed on the importance of the consideration that efforts to secure pure milk satisfying scientific conditions should not, if possible, be permitted to reduce the total quantity of milk available for public use. There is little doubt that immediate action to enforce the supply of milk from non-tuberculous cattle would have this effect, and thus action beneficent in its intention would be inimical to the public welfare.

There is every reason for excluding from milking herds all cows with diseased udders, or which can be shown to be giving milk containing tubercle bacilli. It is advisable to encourage farmers to clear their herds of tuberculosis, and to give special certificates to farmers who sell milk only from cows proved free from tuberculosis by the tuberculin test. It may be desirable to go further than this for small herds of cattle, with a limited supply; for a single diseased cow in a small herd is much more dangerous to human consumers than when the bacillary milk is diluted in a vaster volume of milk. There are those who regard the imbibition of small quantities of tubercle bacilli in milk as a valuable means of securing partial human immunity; but even if this be accepted as possible, the toleration implied by it of tuberculous infection of unknown dosage is unscientific, and the only sensible plan is to pasteurise milk from untested herds. Every human being receives tubercle bacilli of human origin in small doses, and the prevention of human tuberculosis may be said to consist—on the side of infection—in preventing too frequent or massive infection, beyond the powers of personal resistance. This is much more important for young children than for adults, whether the tuberculous infection is derived from milk or from a consumptive human patient.

Pasteurisation then is a chief means of protection against the occasional dangers of milk. It is not an alternative to the hygiene of the cow and of the cowshed, of transport, of sale, and of domestic storage. It is supplementary to them and aids their action. Nor can pasteurisation be said to encourage the continuance of a dirty milk supply. Milk which is dirty does not keep well after pasteurisation, and is thus commercially unprofitable. The methods of pasteurisation have improved, the flash method having been replaced by the "holder method" of pasteurisation, which makes it more likely that the milk will all be subjected to the temperature decided upon. Pasteurisation is still in process of improvement, as there is reason to think that in practice some of the milk may escape too soon from the heating process. Even so the danger of tuberculosis, etc. has been greatly reduced, for dosage of infection is an essential element in the result. The temperature prescribed in the recent Order of the Ministry of Health is not less than 145° F. and not more than 150° F. for at least half an hour, the milk to be immediately cooled to a temperature of not more than 55° F. It is also laid down that any sample of pasteurised milk taken before delivery to the consumer shall not contain more than 30,000 bacteria per c.c. nor any bacillus coli in one-tenth of a cubic centimetre.

It is unfortunate that, in the somewhat hesitating and tentative regulations of the Ministry of Health, it has not been regarded as advisable to regulate the conditions of commercial pasteurisation, which is practised on a large scale without any special certificate being asked for by the producer. It is probable that at the present time most of the milk coming into London is pasteurised, though not always satisfactorily. In American cities such pasteurisation is subject to rigid supervision, an automatic gauge of the temperature of pasteurisation being kept for official inspection: and the system now inaugurated in England, in which it will be possible for vendors to pay for a certificate of permission to sell "pasteurised" milk, while their neighbours are selling pasteurised or partially pasteurised milk without such a certificate and without disclosure of the fact that the milk has been treated by heat, is obviously a system which should not continue. The uncertified and undeclared pasteurisation has real possibilities of mischief; for it leads the unsuspecting purchaser to subject the milk to repeated heating to its detriment. Such doubly-heated milk is liable to produce scurvy and rickets. This naturally leads to the consideration of the drawbacks to pasteurisation of milk. The evidence goes to show that pasteurisation as defined above, followed by rapid cooling, does not spoil the milk. Such milk, like dried milk, has not been shown to produce scurvy: and any fear on this point is averted by the use of fruit juice in small quantities. Although the vitamin-content of milk treated on the "holder" system has not been adequately investigated, experimental observations quoted in the October issue of the *Scottish Journal of Agriculture* show that there need be little apprehension on this head, especially if the precautionary use of fruit juice is adopted. The admirable results of feeding infants on dried milk confirm this opinion.

The general enforcement of pasteurisation of milk is called for in the public interest, and there can be little doubt that step by step this will come into operation. It is the most practical method of State regulation; and it secures immediate safety against serious risks of infection when carried out satisfactorily. For many years efforts to improve the sanitary conditions of the farm and the cow-byre have been made, but with results which are quite incommensurate with the expense involved. By dirt tests, bacterial counts, insistence on cooling of the milk at the farm, and allied measures, both the wholesale purchaser of the farmer's milk and the sanitary authority can do much to increase its cleanliness; but pasteurisation is the essential safeguard in the public interest. Attacks on pasteurised milk are not justified scientifically, and they imply, if successful, a continuance of the supply of infective milk, with the dangers at present associated with its consumption. Pasteurisation is already enforced in a considerable number of American cities, and we would welcome action on the part of the British Government which would permit large local authorities in this country to aid the milk industry and to safeguard the public health by enforcing the pasteurisation under satisfactory conditions of the local milk supply.

The pasteurisation of milk supplies carries with it the distribution of milk in sterilised sealed bottles, which is an important safeguard against domestic contamination, a chief source under present conditions of mischief.

The Ministry of Health has issued regulations also as to superior qualities of milk, which may be described as Certified, Grade A or Grade A (tuberculin tested). Grade A milk is described in the official notice circulated with these regulations as "superior to the ordinary milk of the country and reasonably safe under all ordinary circumstances." Evidently certification of such milk must be made with fear and trembling. According to the schedule of conditions imposed, the cows have not been proved to be free from tuberculosis by the tuberculin test, the chief test imposed being a trimestrial examination of the herd by a veterinary surgeon, who orders the exclusion of any animal "showing evidence of any disease which is likely to affect the milk injuriously." American experience has shown that even with tuberculin testing, it is necessary to pasteurise the Grade A milk supplied for children's hospitals: and the above certificate for Grade A milk cannot be regarded as conferring anything approximating to the security for the consumer which efficient pasteurisation provides. The above-quoted definition conduces to furious thought. We must regard the "ordinary milk of the country"—the milk with which the vast majority of children are supplied—as not "reasonably safe." If so, and it is so, why does the Ministry of Health stop short of a simple regulation requiring pasteurisation of the mass of publicly supplied milk and thus at once ensuring safety from the chief dangers of our milk supply? Why also does it not insist on declaration of pasteurisation when this has been done commercially apart from any regulations for certifying pasteurised milk?

Physics and Psychics.

(1) (*Psychical Research*). *The Goligher Circle, May to August 1921.* Experiences of Dr. E. E. Fournier d'Albe. With an Appendix containing Extracts from the Correspondence of the late Dr. W. J. Crawford, and others. Pp. 81 + plates. (London: J. M. Watkins, 21 Cecil Court, 1922.) 7s. 6d. net.

(2) *The Case against Spirit Photographs.* By C. Vincent Patrick and W. Whately Smith. Pp. 47. (London: Kegan Paul and Co., Ltd., 1922.)

(3) *Cold Light on Spiritualistic "Phenomena": An Experiment with the Crewe Circle.* By Harry Price. Pp. 15. (London: Kegan Paul and Co., Ltd., 1922.) 6d. net.

(1) IN this book Dr. Fournier d'Albe records his experiments with the Goligher medium and Circle, undertaken to corroborate, if possible, the remarkable results claimed by the late Dr. Crawford. In order to explain certain alleged occult phenomena ("raps," "levitations," etc.) obtained with this medium, Dr. Crawford postulated as the agents invisible entities which he called "operators," and believed to be departed human beings (spirits). The *modus operandi* of the "operators" is as follows: From the medium's body, metamorphosed from her "flesh," a substance, indifferently called "plasm," "ectoplasm," "psychic fluid," etc., emanates as an extensible rod, the proximal end of which retains connexion with the medium's body, the distal free end being provided with a "suction grip" to hold, and move, objects. Dr. Crawford not only photographed this "psychic stuff," but also in June 1920 *saw* it and *felt* it wriggling up the medium's legs like a snake. Shortly after this experience he committed suicide, and his researches ceased. Some ten months later Dr. Fournier d'Albe takes up the broken threads. The séance room he describes as feebly illuminated by a one candle-power gas-burner, enclosed in a box with red glass sides so arranged that the medium is in comparative darkness, the floor, the legs of the members of the Circle, and even some of their hands, being in total darkness. Kathleen Goligher, the medium, is seated at one end, so to speak, of the circle of sitters, her father being almost invariably next her.

Dr. Fournier d'Albe placed at the bottom of an empty decanter a glass button, a peg, and a cork, and asked the "spirits" to remove the cork by means of a "psychic structure," but leave the other objects in the decanter. The "spirits," apparently unable to discriminate between the objects, remove the button. Dr. Fournier d'Albe next placed with the button a drop of mercury in the decanter, and requested the "spirits" to remove the former only. After repeated attempts they gave it up, saying, through raps, that they would try again another day. They did—and succeeded. Lastly, to prevent both inversion of the decanter and substitution, Dr. Fournier d'Albe asks them to remove the button from a decanter containing water. After several trials the "spirits" rap out the message that they cannot do so, as the water dissolves the "psychic structure."

By this time the experimenter is becoming disillusioned. Nor are his suspicions allayed by the chiffon-like appearance of the shadowgraph which he took of the "ectoplasm." Finally, when Dr. Fournier d'Albe unmistakably felt muscular movements of both father and daughter going on in unison with the movements of a "levitated" table, when, a little later, he saw a "levitated" stool balanced on the foot of the medium's outstretched leg, he thought it time to conclude the experiments. He sent the medium a cheque, stating he desired no more sittings as, after three months' experimenting, he had gathered no definite evidence in favour of the psychic origin of the phenomena. However, he was persuaded to attend one more sitting at which a great effort was to be made to produce evidential phenomena. Dr. Fournier d'Albe assented, stipulating that the medium's feet be tied to the chair, and her arms held. This was agreed to, but, as is always the case at séances when trickery is precluded, there were no spiritualistic phenomena of any kind, no levitation could be obtained—not even the faintest rap.

Dr. Fournier d'Albe is to be congratulated on his exposure of this notorious medium and Circle. But let the reader be under no misapprehension: although Dr. Fournier d'Albe says Dr. Crawford's experiments are invalidated he yet sees nothing in his own dealings with the Golighers to make him doubt the genuineness of the "spiritualistic phenomena" of Madame Bisson and her medium Eva C. We wonder if he holds the same opinion now that the "phenomena" of this French medium have been dismissed as a "clumsy hoax" by a committee of professors who recently witnessed them.

The book contains an appendix dealing with the correspondence of the late Dr. Crawford and others which the reader cannot afford to ignore, as it furnishes a good insight into the reasoning capacity and "scientific method" of spiritualists.

(2) The authors describe the many methods of taking spirit-photographs, enumerate the devices of mediums for deceiving the public, and, finally, state why they decline to accept the phenomena as genuine. "Of all spiritualistic phenomena," says Mr. Smith, "spirit-photographs are the most obviously fraudulent."

The general argument of believers in spirit-photography is as follows: The ether waves that affect the eye (light) constitute but a small proportion of the complete wave-scale. The photographic plate is sensitive to infra-red and ultra-violet waves, and to X-rays, to all of which the retina is indifferent. Why, therefore, should not the photographic plate respond to "spirit" emanations? The reasoning, while not altogether unsound, calls to mind the advice in the cookery book in the recipe for hare soup—first catch your hare!

The type of spirit-photograph with which this work principally deals is, in the jargon of the cult, an "extra." A bereaved individual gives the spirit-photographer (medium) a description or a portrait of the departed one from whom he wants a sign. After payment of fees he sits for his portrait, which is duly presented with an extra figure thereon that the victim imagines to represent his lost one. Spiritualists claim that hundreds of "extras" have thus been recognised, which only shows how much the psychology of deception accentuates the truism—the wish is father to the thought. The spirit-photographer Buguet was eventually detected and sentenced to twelve months' imprisonment and a heavy fine; yet, despite his confession of guilt and his description of how he had faked the "spirits" on his photographs, witness after witness came forward and swore to having recognised the "extras."

Mr. Patrick, in a careful analysis of "Fairy Photographs," recently published by Sir A. Conan Doyle, directs attention to the many suspicious points demanding further explanation, and he does not hesitate to label the fairies as "fakes."

If only those who desire to receive communications from the unseen would first read this book one of the most pernicious forms of parasitism extant would disappear.

(3) Mr. Price's remarks are significant, as he is a member of the Society for Psychical Research—a society not notoriously addicted to hypercriticism of occult phenomena. To him is due the credit of exposing Mr. Hope of Crewe, the last and most elusive of the three leading British spirit-photographers. Vearncombe had been detected substituting plates. Mrs. Deane, a member of, and strongly recommended by, the "British College of Psychic Science," has also been proved to have tampered with plates. Remained only Mr. Hope and his assistant Mrs. Buxton. To him comes Mr. Price craving a "spirit extra," and armed with a set of four plates secretly marked by X-rays with a stencil design in such way that, *after development*, the whole set of plates would show the complete design, any lacunæ in the latter proving substitution. As a result, Mr. Hope is found "guilty of deliberately substituting his own plates for those of a sitter."

The question which the reader will ask after perusal of these three works is not—Why are there so many deceivers? but Why are there so many dupes? Money—whether fees for "extras" and "psychographs" or substantial royalties for books—may explain the former, but wherefore the victims? The secret, we opine, lies in a defect of education. The young are taught to think, but not *how* to think. It is of minor import whether the conclusions in which thoughts terminate are or are not in accordance with fact. What is of vital importance is the character of the mental processes. It is wrong thinking rather than wrong thoughts that so often mars the individual, undermines society, and imperils the State. *Circumspice!* So long as the young growing child does not learn *how* to think, there will inevitably be an undue proportion of grown-ups whose pitiful logic consists in drawing false conclusions from unsound premises, and to whom error appears as truth provided it be shouted sufficiently loudly and frequently.

C. MARSH BEADNELL.

A Great American Agricultural Cyclopædia.

(1) *Cyclopedia of Farm Crops: A Popular Survey of Crops and Crop-making Methods in the United States and Canada.* Edited by L. H. Bailey. Pp. xvi + 699 + 25 plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1922.) 25s. net.

(2) *Cyclopedia of Farm Animals.* Edited by L. H. Bailey. Pp. xvi + 708 + 25 plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1922.) 25s. net.

DR. L. H. BAILEY has edited more agricultural books than any other man living, but he can never have excelled the two volumes that constitute this Cyclopædia. One volume deals with crops: the other with animals. Of agricultural crops there are in the United States between one and two hundred, quite apart of course from the innumerable plants coming within the province of the horticulturist. In these volumes a generous view is taken, and room is found for medicinal plants and plants yielding fibre, paper, oil, dyes, etc., which would not usually be included in an agricultural list. The animals are less numerous, but even here the list is much larger than would have been expected, and is made to include pets, fish, game, and productive insects, as well as the usual poultry and live-stock. The volumes are the direct descendant of the well-known Cyclopædia of American Agriculture, which has run out of print and by reason of the cost will not be reprinted *in extenso*.

(1) The plan of the volume dealing with crops is to start with an account of the life processes of the plant, well written by W. J. V. Osterhout, followed by descriptions of the effects of stimulation by artificial light, weak poisons, and electricity; then to deal with insect and fungoid pests, and afterwards with plant breeding. The more technical part commences with accounts of the general principles of crop production and farm management, rotations, the growth of crops under cover, etc., and finally comes the long list of field crops, each of which is dealt with in detail.

More than a hundred experts have contributed to the volume and they have amassed a wealth of interesting material, much of which seems very strange to English readers. How many agriculturists in this country are familiar with the agricultural process of "singeing the cholla"? This operation is described in connexion with the cactus which constitutes a considerable part of the vegetation in the southern part of the range country, New Mexico and Arizona. Unfortunately the natural cacti are in the main spiny, and the attempts to introduce spineless forms useful to stock have not proved particularly successful. Nothing daunted, however, the American ranger has proved equal to the situation; by means of a gasoline blow-lamp the spines are singed off, with the result that the cacti become much relished by live-stock and are literally devoured, the prickly pears being eaten nearly to the ground, while only the trunks and woody branches of the chollas (*Opuntia fulgida*) remain.

Turning to agriculture proper, the most important and most distinctive crop of the United States is maize, there always called "corn." It is described as of Mexican origin and related to Mexican grass teosinte (*Euchlæna Mexicana*). The annual value of the crop exceeds that of any other in the States, and is estimated at more than a billion dollars: the most important individual States are Illinois, Iowa, Nebraska, Missouri, Kansas, and Indiana; the least important are Montana and Wyoming. The yield varies from less than 10 bushels per acre in Florida to 35 or 36 bushels per acre in Connecticut, Massachusetts, Maine, and Pennsylvania. Its different varieties are, to a greater extent than those of any other crop, capable of adaptation to local conditions; some mature in seventy or eighty days, and are thus suited to the short seasons of the North; these attain a height of 3 ft. or 4 ft. only. Others found in the South have a growing season of six months, and may reach a height of 20 ft. or more. The crop fits well into rotation farming, and therefore is assured of a permanent place in agriculture.

Another highly important crop is wheat, the area of which increased greatly in the States during the period in which it was shrinking here. Wheat is, however, essentially a pioneer crop, and it tends to shift towards the newer countries. Thus, during the past fifty years the centre of wheat production in the United States has moved westwards more rapidly than has the centre of the population. In 1850 New York was one of the great wheat-growing States; now it produces only a little more than 1 per cent. of the United States crop. Later on, Southern Wisconsin and Northern Illinois became the chief wheat States; now Kansas and North Dakota take the lead. Plant breeders and seedsmen have been busily occupied with the crop, and an immense number of different varieties have been grown: so far back as 1895 the U.S. Department grew more than 1000 different sorts for several years, though a number were found to be identical, and only about 250 were of any value to American growers. Since then the varieties have increased considerably.

Unlike Great Britain, the United States has a large area of spring-sown wheat, and, moreover, much of its wheat is grown under drier conditions than prevail here. There are still sections of the semi-arid country where no rotation is adopted and where wheat simply alternates with summer fallow, though, as Dr. Lyttleton Lyon points out, this will probably before long be replaced by a rotation including perennial grass or leguminous crops left down for some years. Elsewhere in the corn belt much of the spring wheat supply alternates with maize, though the winter wheat is usually grown in a rotation—maize, maize, oats, wheat, clover. This is somewhat of the same type as British wheat growing, with the substitution of wheat or oats for the first maize crop and roots for the second. The harvesting, however, is carried out altogether differently, and we have in this country nothing approaching the "Header" or the "Combine" now in use in parts of the States.

As the book is written for American agriculturists there is no specific account of British crop production. There are, however, casual references, not all of which are accurate. Thus, it is stated that spurrey is cultivated by dairy farmers in Great Britain, which we believe is not the case.

(2) The volume on animals is equally rich in stores of interesting and valuable material. It is gratifying to a native of Great Britain to find how large a part is played by animals which originated here: horses,

sheep, cows, pigs as used on the best farms have been distributed from this country, which still fortunately retains its best studs. British readers will turn with much interest to the account of the bison, which, it is suggested, has agricultural possibilities. It is not in itself a particularly tractable animal; the young calves are ready to fight within a few minutes of birth; but it crosses with the domesticated cow to produce a hybrid known as the "cattalo," which is said to offer possibilities.

Altogether the volumes will be found of much value to the student of agriculture, and they reflect great credit alike on the editor, the contributors, and the publishers. E. J. RUSSELL.

History of Electrical Science.

Bibliographical History of Electricity and Magnetism, Chronologically Arranged. Compiled by Dr. P. F. Mottelay. Pp. xx+673. (London: C. Griffin and Co., Ltd., 1922.) 42*s.* net.

THE title of this book and its subtitle, "Researches into the Domain of the Early Sciences, especially from the Period of the Revival of Scholasticism, with Biographical and other Accounts of the most Distinguished Natural Philosophers throughout the Middle Ages," well describe the contents. Every scientific man is interested in the early days of science, and most of them know a few traditions about its history. It will be a boon to them to find out how far these traditions are justified by the facts, and this book of Dr. Mottelay's, whose death we had recently to deplore, will be of the greatest assistance to them. The volume gives very complete references to all the discoverers of the laws of electricity and magnetism and the writers on these subjects. The author starts from the dawn of authentic Chinese history (2637 B.C.) and ends with Christmas day 1821, when Faraday converted electrical into mechanical energy by causing a wire carrying a current to rotate in a magnetic field.

Many photographic reproductions are given of pages from ancient books and manuscripts. In particular the reproductions of pages from the "Epistola . . . de magnete" of Petrus Peregrinus (1269) taken from the Bodleian MS. and from an almost illegible MS. in the Bibliothèque Nationale at Paris are extremely interesting.

Roger Bacon, a contemporary of Peregrinus, describes him as a "thoroughly accomplished, perfect mathematician." He wrote the earliest-known treatise on experimental science and gave the first description of a pivoted compass. A full description is given of Dr. Gilbert's (1600) "De magnete . . .," in which reasons are given for supposing that the earth is a magnet. Sir Isaac Newton in a private letter (1716) seems to have partially anticipated Franklin's discovery that a lightning flash was electrical in origin. He writes: "I have been much amused by ye singular φενομενα resulting from bringing a needle into contact with a piece of amber or resin fricated on silke clothe. Ye flame putteth me in mind of sheet lightning on a small—how very small—scale." It is not generally known that the great French physicist and mathematician Poisson described the method of obtaining the horizontal value of the earth's magnetic field in absolute measure (1828). Sturgeon mentions that Snow Harris, who used strips of copper for his lightning conductors, carried the lightning conductor of a small man-of-war through the powder-magazine!

This volume deserves a place in every scientific library. To electrical engineers of all nationalities it makes a special appeal. A. R.

Organic Chemistry.

(1) *Grundlegende Operationen der Farbenchemie.* Von Prof. Dr. H. E. Fierz-David. Zweite verbesserte Auflage. Pp. xiv+266. (Berlin: J. Springer, 1922.) 300 marks; 12*s.*

(2) *Organic Chemistry.* By Prof. W. H. Perkin and Prof. F. S. Kipping. Entirely new edition. Part 1. Pp. xi+681+xx. (London and Edinburgh: W. and R. Chambers, Ltd.; Philadelphia: J. B. Lippincott Co., 1922.) 8*s.* 6*d.* net.

(3) *Trattato di chimica generale ed applicata all' Industria.* By Prof. E. Molinari. Vol. 2: Chimica organica. Parte seconda. Terza edizione riveduta ed amplicata. Pp. xv+625-1406. (Milano: Ulrico Hoepli, 1922.) 48 lire.

(1) THE first edition of Dr. H. E. Fierz-David's volume on the chemistry of dyeing has been translated into English, and is by now well known to English chemists connected with the manufacture of synthetic dyestuffs and to students of chemistry preparing for that branch of industry. It is a book which has supplied a distinct and ever-increasing demand.

The preface to the new German edition is interesting in so far as the author, who thought fit to suppress certain processes in the interest of the home industry, now finds that these methods with little modification are common to all countries manufacturing "intermediates," and that there is nothing which he has described which will affect the Swiss colour-makers.

(2) The text-book of organic chemistry by Perkin and Kipping is too well known in our universities and colleges to need more than a brief reference to the new edition. It contains some important additions, notably

chapter 42, in which an account is given of the use of catalysts in organic chemistry, the hardening of oils, Thiele's theory and the cracking of petroleum. An extension of the sugar group is given in chapter 39. No doubt in a future edition of the book these somewhat incongruously grouped subjects will be allotted their proper places.

Minor modifications and additions are the explanation of the reactions which occur in the preparation of formic acid and of allyl alcohol from glycerol and oxalic acid in accordance with Chattaway's work and Werner's method for the preparation of methylamine from formaldehyde. Some parts of the chapter on the terpenes have been modified, and several new synthetic products have found a place.

(3) Prof. Molinari's organic chemistry, which was translated into English by T. H. Pope, constitutes vol. 2 of his treatise on chemistry. Since its first appearance a second and third edition of the organic section have appeared, the last being so much enlarged as to necessitate a division into two parts, each of substantial dimensions. The first part has already appeared in its English dress, and no doubt the second part, the subject of the present notice, will soon follow. Although this treatise has already been reviewed in these columns (NATURE, May 12, 1921, p. 325), it may be again stated that the organic section is in many respects unique. As the title states, it deals with general chemistry and chemistry applied to industry. The industrial part is not merely a bare text-book outline of the process, such as the text-book compiler occasionally introduces from conscientious motives, but without either knowledge of or interest in the subject. The descriptions are such as might be found in a specialised treatise dealing with the processes and are illustrated by excellent diagrams and drawings of apparatus, often with cost of plant and appliances. Moreover, analytical methods and figures are given with numerous statistics of imports, exports, and prices.

Such a comprehensive combination of the theory and practice of chemistry is in itself illuminating, and one may turn over page after page and find a store of information, of which the non-technical chemist has probably never heard. It gives a clear picture, more impressive indeed than the splendid "Dictionary of Applied Chemistry," of the invasion of industry by science and the widespread extent of that invasion. It is a treatise upon which both author and publisher and also the translator may be congratulated, and one feels sure that the friendly appeal of the publisher attached to the volume by a slip of paper in which he "offre questo volume in omaggio con la preghiera di raccomandarlo agli amici e favorirne la diffusione" will find a favourable response. J. B. C.

Our Bookshelf.

The Old English Herbals. By Eleanour Sinclair Rohde. Pp. xii + 243. (London: Longmans, Green and Co., 1922.) 21s. net.

THE subject of herbals has always attracted students of botanical history. The beauty of their figures, the quaintness of their language, their appearance as the herald of the scientific development of botany, their appeal to the folklorist and designer, have all combined to create a demand for these books. Dealers have not been backward in reflecting the extent of this demand in the prices they have put upon them.

It may be doubted, however, whether the scientific student of the history of science will pay quite the same importance to these herbals as is attached to them by the collector. Undoubtedly the manuscript herbals and some of the earlier printed herbals represent a stage in the development of science. For the most part, however, their preparation has demanded little thought—except from the illustrator—and no general ideas. Some of the most picturesque of them are even behind the scientific development of the time in which they appeared.

Some years ago Mrs. Agnes Arber, in her admirably illustrated and arranged work on "Herbals," produced a scholarly general account of these books. Miss Rohde confines herself to those of English origin. The choice is, perhaps, unfortunate in one important respect since, in fact, few of the herbals which had any influence on the course of botany were produced in this country. On the other hand, her choice has provided an admirable opportunity for giving a picture of the attitude towards botanical studies in this country in the sixteenth and seventeenth centuries. The book, too, is packed with a good selection of the very quaintest quotations, by which the sternest critic will be at once charmed and disarmed. If they are not always relevant they are always entertaining. No reviewer will put down the volume without the feeling that whatever its faults he has been presented with a most readable and entertaining book, and after all, what are books for save to be read and to entertain? The would-be writer of the slashing article—if any of that iron breed yet survive—will find that Miss Rohde has smiled him into good humour long before he has turned the second cover. The illustrations, too, are excellent, the volume is remarkably cheap, and the bibliography useful.

Essentials for the Microscopical Determination of Rock-Forming Minerals and Rocks. By Dr. A. Johannsen. Pp. vi + 53. (Chicago: University of Chicago Press. London: Cambridge University Press, 1922.) 11s. net.

PROF. JOHANNSEN has deserved well of petrologists. The present publication by him comprises some half-a-dozen tables, explained and illustrated by notes and diagrams. The minerals are classed in the first place according as they are opaque or transparent, isotropic or uniaxial or biaxial, uncoloured or coloured, and pleochroic or non-pleochroic, and to each of these divisions is allotted a table. In the tables the anisotropic minerals are arranged vertically in the order of their birefringence indicated in the central column; and laterally from the centre outwards, according to their refractive indexes shown at the top of the table. The range of the refractive index of each mineral is given by a horizontal line, somewhat in the same manner as in the "Petrographic Methods" of Dr. Holmes.

Comparatively little use is made of the optic axial angle, though even a rough estimate involving no elaborate procedure or calculations may be quite useful. Another observation which can be made without difficulty is whether the direction of maximum absorption coincides with the fast or the slow direction of vibration. The sections dealing with the felspars, pyroxenes and amphiboles are excellent, but the use of the term melatope (p. 32) for the point of emergence of an optic axis in interference figures should have been explained.

The concluding pages are devoted to the author's new quantitative classification of igneous rocks, which is based on the "mode," the actual minerals present, instead of on the "norm." Most petrologists in this country believe, however, that any quantitative system of classification is essentially misleading.

J. W. EVANS.

Annuaire pour l'an 1923 publié par le Bureau des Longitudes. Pp. viii + 654 + A118 + B12 + C16 + D72. Supplément à l'Annuaire du Bureau des Longitudes pour l'an 1923: Distribution des pluies en France. 15 planches. (Paris: Gauthier-Villars et Cie, n.d.) 6.50 francs.

THIS very handy little volume is now widely known, and the issue for 1923 shows no falling off in its general utility; it contains all the usual calendar information, and has tables and descriptive matter dealing with all classes of heavenly bodies; there are also physical, mensurative, and geographical tables. The only point in these tables that seems to call for some criticism is the section relating to comets. The orbits given are in many cases by no means the latest or most accurate available; the latest return of Encke's referred to is that of 1914, though it has been seen since then, in 1918 and 1921. The date given for the perihelion passage of the comet Pons-Winnecke in 1921 is June 20, which is eight days too late; it is also curious that this comet is called simply Winnecke's, forgetting that it was first found by the French astronomer Pons, and that its periodicity was known long before Winnecke found it in 1858.

The special essay contained in this volume is by M. G. Bigourdan on the climate of France; it contains many tables and diagrams, and discusses the different types of climate belonging to different regions, and also the diurnal and annual variations in cloud, rain, etc. M. Bigourdan describes the system of weather forecasts by wireless, which are now distributed daily, and should be of great service to agriculturists.

There are obituary notices of Gabriel Lippmann and Jules Carpentier, both of whom died last year.

The small suggestion may be made that the leaves of the book should be cut, as is usually done in volumes of this character, where ease of reference is a desideratum.

A. C. D. C.

Common Stones: Unconventional Essays in Geology. By Prof. G. A. J. Cole. (Common Things Series.) Pp. 259. (London and New York: Andrew Melrose, Ltd., n.d.) 6*s.* net.

PROF. COLE's twenty essays on common stones are written with a literary grace and charm which should give this book a firm place among British popular presentations of science. It should do to-day the service which Kingsley's "Town Geology" did for an earlier generation. The volume sketches the modern theories of rock formation, on which the author writes with the knowledge of an expert, while his references to the field occurrence of the rocks make the reader share with him the pleasure of many field days. The chapters which deal with sedimentary petrology are especially useful; one of the most attractive is that on soils, as might be expected from the head of a Geological Survey which has devoted especial attention to agricultural geology.

Advanced students would profit by reading these essays, for they quote much new information and many unfamiliar instances; the author, for example, lays stress on the origin of oolitic structures by chemical processes, and on the formation of corries by nivation instead of by glacial erosion; he rejects some conclusions based on the low ash content of anthracite; in emphasising the need for safeguarding our future coal supplies he remarks wittily that a century hence a chapter on coal would be out of place in his volume, as coal would then be regarded as a precious and not as a common material.

The humanistic feeling shown in this book by its high literary quality and its frequent reference to the early founders of geology would make its perusal of special benefit to science students in view of the growing specialisation in their preliminary education.

Kincardineshire. By the late George H. Kinnear. Pp. xi + 122. (Cambridge: At the University Press, 1921.) Price 4*s.* 6*d.* net.

KINCARDINESHIRE, though one of the smaller of the Scottish counties, is a compendium of Scottish geographical types, for it includes typical areas of highlands, lowlands, and of the eastern coastal districts. Kincardine is interpreted as "the end of the high lands" and it is used for various localities in Scotland; the name is appropriate to this county, as it includes the eastern end of the Grampians. The chief lowland area is the plain known as "the Howe of the Mearns" which is the eastern end of the Vale of Strathmore. The coast is very variable in character, and unusually picturesque; part of it consists of soft beds which are undergoing rapid abrasion by the sea; elsewhere occurs an alternation of hard rocks which project in headlands such as that surmounted by Dunnottar Castle, and of soft bands which have been worn back into bays. The interest of the coastal scenery is enhanced by the numerous stacks and caves. The headlands act as groynes, and their protecting effect was shown in the case rendered classic by Lyell, who recorded the destruction of the village of Mathers on a single night in 1795 owing to the sea breaking through a ledge of limestone which had been weakened by quarrying. Fishing villages are numerous along the coast, and one of them, Findon, has given its name to the "finnan haddock." The population is lowland and included the ancestors of Burns. The sections on the geology and meteorology of the country are well up-to-date; the author, for example, attributes the mild climate of Scotland to the south-west winds and not to the discredited Gulf Stream.

Zeitschrift für angewandte Geophysik. Unter ständiger Mitarbeit zahlreicher Fachgenossen. Herausgegeben von Dr. Richard Ambronn. Vol. i., Part I. Pp. 32. (Berlin: Gebrüder Borntraeger, 1922.) 20*s.*

While the attention of geologists is justly turned to physical considerations, in view of our immense ignorance of the inner constitution of the earth, it may be questioned if it is wise at the present time to inaugurate a special journal for geophysics. The first part of the *Zeitschrift für angewandte Geophysik* is issued under the editorship of Dr. R. Ambronn, of Göttingen, by one of the most enterprising firms in Germany. Its thirty-two pages are priced at twenty English shillings, which puts it beyond the reach of scientific men who are also taxpayers in our islands. We cannot help feeling that the money would be better spent in supporting and, if necessary, enlarging the scope of one of the German geological journals that have already won a world-wide reputation.

Dr. Ambronn shows how the measurement of radioactivity, of variations in gravity from point to point, of the increment of temperature with depth, and of the propagation of earthquake waves, subjects that truly belong to the domain of geophysics, find their applications in the search for ore-bodies, basins of light minerals, such as rock-salt, and of petroleum. Abstracts are given of papers which deal with these or similar subjects; but they will surely fall under the watchful eye of the editor of the *Geologisches Zentralblatt*, to mention only one well-known journal. We compliment Dr. Ambronn on his energy, but not on his adding yet another care to our librarians, however casually his new periodical may appear.

G. A. J. C.

Essays on the Depopulation of Melanesia. Edited by Dr. W. H. R. Rivers. Pp. xx+116. (Cambridge: At the University Press, 1922.) 6*s.* net.

It is difficult to lay too much stress on the practical value of this small collection of essays written by members of the Melanesian Mission and others. The fact that the volume is edited by the late Dr. W. H. R. Rivers is a guarantee both of accuracy and impartiality. Sir Wm. Macgregor and Mr. C. M. Woodford, who write from the point of view of the official, and Dr. Speiser of Basle, who writes as an anthropologist, fully bear out the contentions of the members of the Mission. The authors, without exception, agree that depopulation in Melanesia is to be attributed largely to the breaking up of custom which has followed contact with the white man. When the spiritual power of the chief has been discredited in the eye of the native by the white man, the temporal authority, which is based upon it, fails to preserve traditional law, order, and morality. Dr. Rivers, in a concluding essay, however, suggests that the most important factor is psychological. The native, he maintains, has lost all interest in life through the suppression of customs such as head-hunting, with which have disappeared a large number of closely related social activities. His suggestion that total suppression of such customs could be avoided by substitution of harmless elements is deserving of careful consideration.

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

The little book under notice consists of a series of lectures illustrating simply the Quaker attitude to various problems. In the chapter on biological foundations, the author attempts to show that the fundamental doctrines of Quakerism, *i.e.* the acknowledgment of no final authority, whether Church or Bible, except the Word of God in the heart, are more in accord with the teachings of biological science than the dogmas of any other religion. The point of view is interesting, although it is doubtful whether the teachings of science, as such, are usefully fitted on as justification for a body of religious beliefs.

The author develops his contention that the Quaker ideal is Christianity from which all accretions in the form of Hebrew, Greek, and Roman sources have been eliminated. He also discusses the Quaker attitude towards war.

The essays all set forth high moral ideals, for the value of which the moral life of the believer in them is the sole criterion.

Chemistry of To-day: The Mysteries of Chemistry lucidly explained in a Popular and Interesting Manner free from all Technicalities and Formulæ. By P. G. Bull. Pp. 311. (London: Seeley, Service and Co., Ltd., 1923.) 8*s.* 6*d.* net.

According to the preface, this is not intended as a text-book, but as an attempt to give some account of modern chemistry to the general reader. It should fulfil this object: the style is bright and interesting, the matter appears to be accurate, and an extensive field is covered—very superficially for a text-book, but probably adequately for the intended reader. There is perhaps too great a tendency to "sensational" topics—the frontispiece representing a well-known man of science "bombarding" atoms half the size of himself with "nuclei of helium" as big as cricket balls, and producing a pyrotechnic display, is an example of what we mean by this criticism. There are good half-tone plates, but the line-drawings are poor.

The Psychology of Society. By Morris Ginsberg. Pp. xvi+174. (London: Methuen and Co., Ltd., 1921.) 5*s.* net.

In short compass Mr. Morris Ginsberg discusses critically with admirable lucidity the psychological basis on which much recent treatment of social problems is founded. He has a keen eye for essentials, and a sense of perspective. He presents tersely and fairly the salient arguments of writers who count and pronounces clearly and courteously well-considered judgment. A little book but a good one.

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.*]

The Spectrum of Neutral Helium.

AT the end of his letter to NATURE of January 13, p. 46, Dr. Silberstein appends a note to the effect that he has been able to express the diffuse series HeD′ in the form

$$n = 109723\{1/2^2 + 1/10^2 - 1/9^2 - 1/m^2\}$$

with errors of 0·7Å for the second line, and of between 0·1Å and 0·35Å for the next ten. May I be allowed to offer the following remarks:—

(1) A formula determined on a definite hypothesis, as here, ought to reproduce the wave-lengths within observation errors or at least be able to account for deviations from them. According to the data given the deviations amount to between 100 and 200 times the possible errors (700 for the second). The usual empirical formula reproduces all the lines within these limits, except the first, the O − C errors being 0·000 for $m = 2, 3, 4$ and the largest for higher values of m being 0·02. The limit is definitely within $\pm$ 0·1 of 27175·68 1/Å, in other words, $N(1/2^2 + 1/10^2 - 1/9^2)$ must have this value. This, of course, is possible by an empiric choice of N, but it would probably upset even the rough agreement when this is used in the last term N/m^2.

(2) That the diffuse singlet series HeD′, and indeed also the diffuse doublet HeD″, can be represented roughly in the form $A - N/m^2$, is due to the fact that for this special series the denominator in the empirical formula, $m + 0{\cdot}996369 + 0{\cdot}002917/m$, is necessarily very close to a whole number, and its deviations therefrom produce comparatively small effects when m becomes large. A similar arrangement in the cases of S′, S″ or P″ would be found impossible.

(3) But the most fatal objection is that $N(1/2^2 + 1/10^2 - 1/9^2)$ must also be the first term of the p' sequence, which is at least numerically represented by $p'(m) = N/(m + 1{\cdot}014593 - 0{\cdot}004392/m)^2$. Here again the denominator is nearly an integer (though further from it than in $d'(m)$), and no doubt it could also be represented by N/m^2, with greater deviations than in the case of d', but the first term would then be $N/2^2$ and not $N(1/2^2 + 1/10^2 - 1/9^2)$.

It is perhaps a difference in temperament, but to me Dr. Silberstein's note appears rather to weaken than to give a "much stronger support" to his proposed theory. However, I am not here discussing his hypotheses, one objection to which I raised in a letter to NATURE on September 2 last (p. 309) which Dr. Silberstein has not dealt with.

W. M. HICKS.

January 15.

Some Experiments on Rate of Growth in a Polar Region (Spitsbergen) and in England.

IN a recent paper (Journal Mar. Biol. Assoc., vol. 12, 1920, p. 355) attention was directed by me to the lack of critical evidence bearing on the theories offered to explain (*a*) the abundance of life in polar regions, and (*b*) the occurrence of several generations of a species living side by side in polar waters. Murray and Loeb and others have suggested that an explanation of these phenomena may be found in a greatly retarded rate of growth which, it is *postulated*, must occur in the low temperatures prevailing in these regions. The present writer urges (*a*) that we know nothing about the rate of growth of organisms in polar regions, and (*b*) that the kind of metabolism of animals in polar regions—and in deep-sea situations—is not necessarily the same as that in temperate or tropical regions. A given organism may be regarded as a machine, but it is perhaps derogatory to the kind of machine one is dealing with to assume that other life-machines existing under totally different conditions are necessarily governed by identical applications of the same laws; for example, it does not necessarily follow that because the rate of metabolism in tropical or temperate animals falls off rapidly with decreasing temperatures approaching 0° C., that metabolism in polar animals is necessarily of the slow rate of temperate animals at polar sea-temperatures. No reason has yet been shown that adaptation of metabolism cannot occur; on the contrary, there is every reason to expect such adaptation.

The following experiments on the rate of growth in marine organisms at Spitsbergen—designed to obtain information on these problems—have given, however, mainly a negative result, but as in one case a positive result—yielding a much greater rate of growth than has ever been suspected—has been obtained, it is worth while recording the result now. It is hoped to write a fuller account later, giving details of the apparatus used, in the Journal of the Marine Biological Association.

In 1921 simple experiments on rate of growth were carried out in 7 fathoms of water close to Anser Island in Klass Billen Bay, Spitsbergen, by the biologists of the Oxford Spitsbergen Expedition, and mainly under the direction of Mr. Julian Huxley and Mr. A. M. Carr Saunders. The present writer had hoped to carry out the experiments under personal supervision, with the promised help of Dr. Hoel of the Norwegian Fishery Board, but circumstances nullified these arrangements.

Two pieces of apparatus were used—a galvanised iron-wire network cage of ⅝-inch mesh and 5 feet by 4 feet by 9 inches was tarred and moored to the bottom of the sea after putting a large number of dried oyster shells inside it; and a floating tarred wooden raft with strings of shells attached was anchored in the sea near the cage. The apparatus was put in the sea on June 27, 1921; the raft and shells were inspected by Mr. Huxley on July 16, and—owing to the illness of Mr. Carr Saunders—finally hauled by Mr. R. W. Segnit, geologist, and Capt. Johannsen on August 24, 1921.

On July 16 Mr. Huxley found practically no growth on the raft nor on the shells on the raft, but the cage was not hauled. On hauling the cage on August 24 the sea-urchins shown in Fig. 1 were found *inside* the cage. The door of the cage, which only covered the central portion of one long face of the cage, was found to be closed and *laced* as had been previously arranged on putting the cage in the sea. The astonishing sight of the relatively large sea-urchins inside the cage attracted attention at once, and a fruitless examination of the cage was made for any means of access greater than the mesh of the cage. The conclusion was therefore drawn that the urchins must have entered the cage while small, *i.e.* of a diameter upwards to about 1·6 cm., and grown to the size observed, *i.e.* upwards to about 2·9 cm. in diameter—excluding spines—within 58 days.

This result was regarded as very important, and a confirmatory experiment tried again at the same spot in 1922, under the direction and by the kindness of Mr. J. Mathieson, of the Scottish Spitsbergen Syndicate scientific staff. When Capt. Johannsen hauled the cage in 1922, however, no urchins were found this time in the case, and no growth observed on the cage or shells.

In 1921 Mr. Mathieson took a few sea-temperature observations which confirm the general indication that no higher sea-temperatures than 4° C. prevailed during the course and in the locality of the experiment.

The almost complete absence of growth on July 16, 1921, on Mr. Huxley's inspection is not significant, as I have found that failure to infect shells obviously with growth may occur in a similar period at Plymouth. The absence of growth, other than the sea-urchins, on August 24, 1921, may or may not be due to slow rate of growth and cannot be discussed adequately here, but at Plymouth the writer has found that in a period of 3 to 6 weeks in summer experimental shells may become covered with extensive growths of marine organisms, some of which may indeed have already attained sexual maturity. There is no doubt that the Spitsbergen sea-urchins were browsing on the oyster shells in the cage. An analogous result has also been obtained in cage experiments at Whitstable, where more than twenty relatively large starfishes (*A. rubens*), of a diameter of upwards to 16·8 cm. as measured from tip to tip of alternate arms, have been found on different occasions inside cages exactly similar to that used at Spitsbergen. In these cases there can be no doubt that the starfishes were attracted to the cage by the dead or dying animals inside the cage.

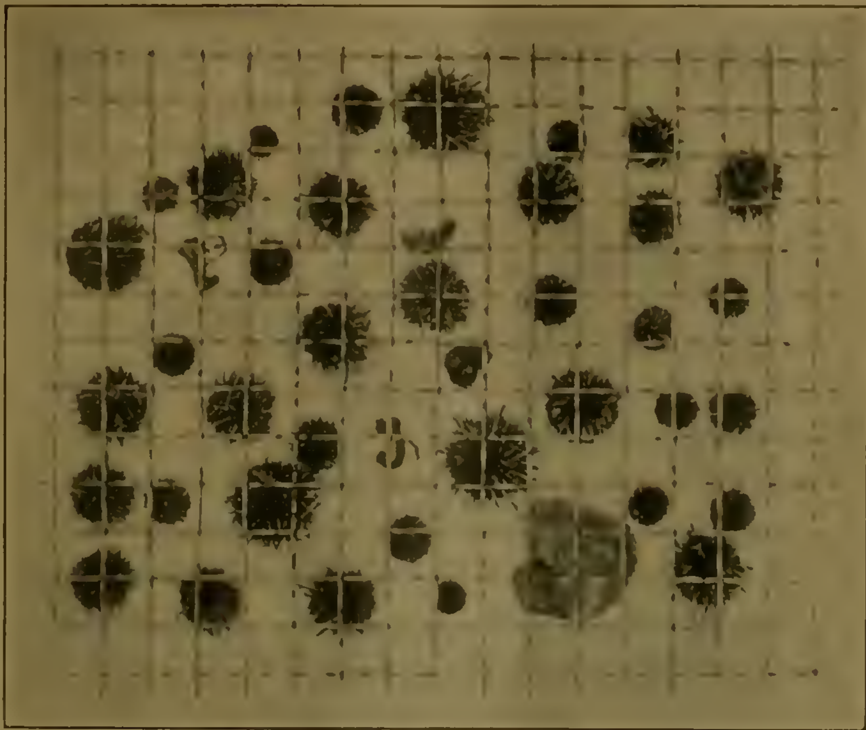

Fig. 1. Photo[1] of sea-urchins from the cage experiment at Spitsbergen, 1921, seen through a grating of the same mesh as the cage. (¼ natural size.)

The rate of growth of sea-urchins in temperate waters under natural conditions is not known with accuracy, but Elmhirst estimates (see Nature, November 18, 1922)—and I agree—that *E. esculentus* (which is a large species) may grow to a diameter of 4 cm. in one year. In a similar cage experiment on oysters at Whitstable a sea-urchin, *E. miliaris* (a relatively small species which does not attain more than about one-fourth the size of *E. esculentus*), was obtained on March 11, 1921, of a diameter of 2·7 cm. (excluding spines) after the cage had been in the sea 65 days, giving a minimum growth in the period of 1 cm. in diameter. On another occasion specimens of *E. miliaris*, of a diameter of upwards to 3 cm., were taken from the bottom of a floating coal-hulk, the *London City*, moored at Brixham, on August 1, 1911, after that vessel had been in the water after cleaning since April 1910. These sea-urchins were therefore rather more than one year old. The sea-urchins from the Spitsbergen cage experiment have not yet been definitely identified, but they probably grow to about the same size as *E. miliaris*.

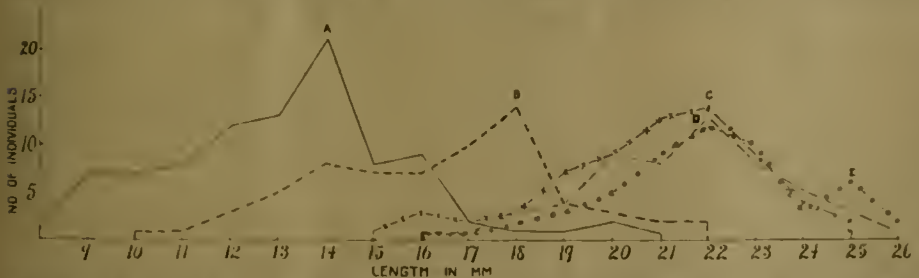

Fig. 2.—Showing[1] rate of growth of a fixed population of marked cockles (*Cardium edule*) kept in a box with perforated sides and top fixed to the bed of the River Yealm, near Plymouth. The box was visited at intervals of one month, and the cockles measured.

A, size of cockles, August 16, 1919; B, September 12, 1919; C, October 11, 1919; D, November 10, 1919; E, December 10, 1919.

Note the practical cessation of growth after about October 11.

Other marine animals—for example, cockles—grow shell very rapidly in English waters in the warm months of the year, and may add from 4 to 6 mm. in length to their shell per month for 6 or 7 months. (See Fig. 2, which shows some unpublished results of experiments in 1919–20 on growth in a fixed population of marked cockles kept in a perforated box fixed to the bed of the River Yealm, near Plymouth.)

Thus the growth of the Spitsbergen sea-urchins compares favourably in rate with that of calcareous marine animals in England, and indicates a rate of growth in marine animals generally in polar regions

[1] The writer is indebted to Mr. A. J. Smith for the photo (Fig. 1), and to Mr. E. Ford for the lettering in Fig. 2.

not previously anticipated; but further experiments are required to confirm the result obtained before drawing the important conclusions it appears to warrant.

It is hoped to repeat this experiment and others at Spitsbergen in the future; but it is desirable that other workers more favourably situated should also carry out similar experiments extending over a longer period.

The actual outlay of expenses for the experiment in 1921 was borne by the Marine Biological Association, and in 1922 by a Government Grant from the Royal Society, but in both years essential help was provided by the Scottish Spitsbergen Syndicate and its scientific leader, Mr. J. Mathieson.

J. H. ORTON.
Marine Biological Laboratory, Plymouth,
December 15.

Separation of Mercury into Isotopes in a Steel Apparatus.

BY 305 hours of repeated fractional vaporisation from a steel trough in a vacuum at low pressures we have obtained a difference of 0·1 unit in the atomic weight of mercury without other cooling than that given by ice. The trough holds 190 c.c. of mercury, but another larger apparatus has been constructed in which the capacity is 10 kilos. In this the mercury

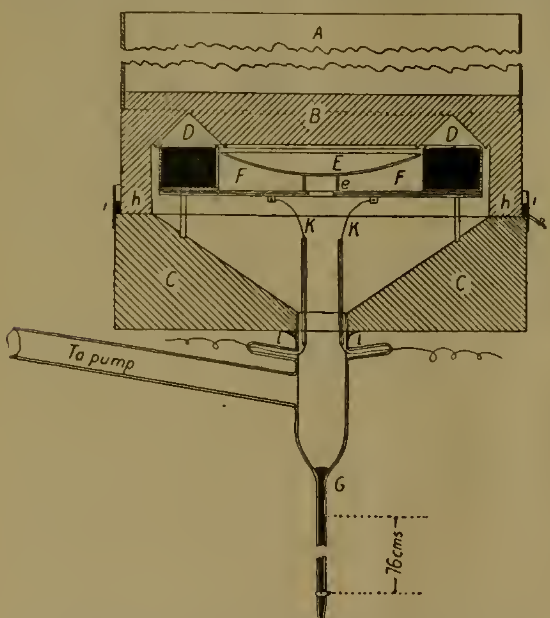

FIG. 1.—Steel apparatus for the separation of mercury into isotopes by vaporisation. *A*, Cylinder for ice; *B*, circular condensing roof, made of steel; *CC*, drain for the light fraction, made of steel; *DD*, annular steel trough holding 190 c.c. of mercury; *E*, watch glass with hole in centre, supported on a short glass tube *e*: *FF*, heating element made of calorised wire and supported on glass rods; *G*, collecting tube made of glass; *hh*, ground joint; *ii*, mercury seal; *K'K'*, platinum wires; *ll*, ground joint and sealing wax.

is heated by an insulated wire which lies in the bottom of the trough, the insulation being obtained by a coating of magnesium oxide, which is covered with a steel sheath. This wire is produced by the General Electric Company.

The details of the apparatus are exhibited in Fig. 1. By means of the tube *G* the sample may be divided into as many fractions as is desired. In the newer form of apparatus the wires used as leads to the heating coil pass through insulators in the bottom steel plate, and not through the upper part of the tube *G*. The principle of the apparatus is that the lighter molecules, which vaporise more rapidly, strike the slanting roof above *D*, and collect in drops. These drops do not fall back into the trough of mercury, but roll down the slanting ceiling until they reach its edge, when they drop into the inverted cone in the lower steel plate, and then into the glass tube *G*, which has a capillary of 800 mm. length at the lower end.

The progress of the separation was followed by the use of Fig. 2, due to Mulliken and Harkins, and it was

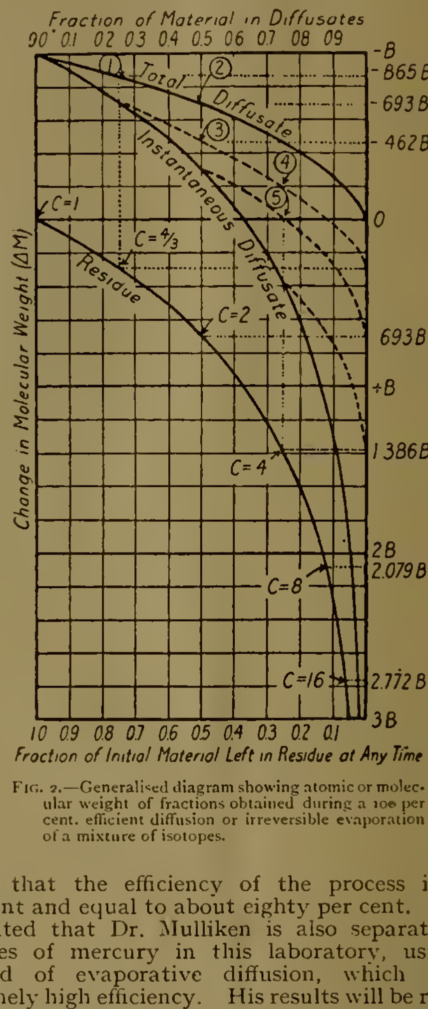

FIG. 2.—Generalised diagram showing atomic or molecular weight of fractions obtained during a 100 per cent. efficient diffusion or irreversible evaporation of a mixture of isotopes.

found that the efficiency of the process is quite constant and equal to about eighty per cent. It may be stated that Dr. Mulliken is also separating the isotopes of mercury in this laboratory, using the method of evaporative diffusion, which has an extremely high efficiency. His results will be reported separately. Our own work will be described more fully later, in the Journal of the American Chemical Society.

WILLIAM D. HARKINS.
S. L. MADORSKY.
The University of Chicago,
December 22.

The Rule of Priority in Nomenclature.

As a teacher of palæontology and keeper of palæontological collections, I may perhaps be permitted to bring forward for discussion some trenchant points which seem to call for immediate action.

The rule of priority was originally intended to be a help in clearing away obscurity in nomenclature, but it is now seen that the strict observance of this rule is having a reverse effect.

The notice by E. H.-A. and A. E. of Cushman's "Shallow-water Foraminifera of the Tortugas Region" (NATURE, June 3, p. 708) is timely, for there they point out, "It appears to be undesirable to complicate synonymies by the revival of early names." They also deprecate the resuscitation of "Discorbis" for "Discorbina," and "Quinqueloculina" and "Triloculina" for "Miliolina." These minor differences in the plans of growth are not generic, for we find them, as often as not, slipping past the boundaries we have set for them.

Names of genera, especially those of the mollusca, are out-of-date in textbooks almost before they reach the hands of our students. Thus Pleurotoma of Lamarck was changed, after many years of usage, to Turris of Bolten, through the unfortunate discovery of a catalogue in which genera were denoted by a known species, *Turris babylonica*, which happens to be first on the list. As a case in point, the student gets familiar with Turris, but in a few months the teacher has to inform him that Turris is not only extremely restricted but unrepresented in Australia, and the genus has been split up, not into subgenera, but into many new genera. Museum labels to the number of several hundreds have to be rewritten, and almost before the ink is dry another change may be made.

The rule of priority is a good one within bounds, but should there not be a retrospective limit placed on many groups, dating say from the time when they were first written upon with authority? This limiting date might well be settled by a conference of workers in those particular groups. In some instances this has been done, and flagrant offences against reason have been prevented. Thus, in 1916 a motion for the suspension of the rule in regard to the genera Holothuria and Physalia was passed by an American conference. In one case "Holothuria" was the name given in 1758 to the "Portuguese Man-of-War," and later, in its familiar sense, to the Bêche-de-Mer, by Bruguière in 1791. According to the rule, "Holothuria" or "Bêche-de-Mer" being invalid was to be superseded by "Physalia," the name accepted previously for the "Portuguese Man-of-War." "Holothuria" would have become "Boadschia" of Jaeger, 1833, and "Physalia" would have become "Holothuria"!

Even the indispensable and invaluable "Index Animalium" of Chas. D. Sherborn will not entirely remove our troubles, for doubts will arise as to an author's meaning on account of bad figures and descriptions. It is, therefore, of paramount importance that a consensus of opinion be obtained for each group as to specific limitations and interpretations of authors' names, and thus prevent those feelings of despair which overtake the specialist, and more especially the general worker, at the present time.

F. CHAPMAN.

National Museum, Melbourne.

Selective Interruption of Molecular Oscillation.

In NATURE of July 22, 1922, vol. 110, p. 112, correspondence occurred regarding the possibility of selectively interrupting haphazard molecular oscillation by means of special apparatus, narrower in certain specific directions than the mean free path of the gas in which it was immersed. In view of the fact that such methods have now been independently put forward by Mr. H. H. Platt in America (U.S.A. Patent, 1,414,895), the following aspect of the problem may be of interest, particularly since the possibility would appear to be rendered very much more clear by so regarding it. Fig. 1 represents a portion of a cone longer than that previously considered, its diameter, however, still being considerably less than the mean free path of the gas concerned, so that molecules of the latter may frequently cross from side to side without intermolecular interruption.

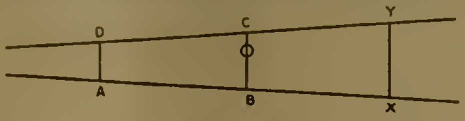

FIG. 1.

Let O be any little circle (or sphere if three dimensions are being considered) in this cone, and consider those molecules proceeding from collision, necessarily with equal probability of motion in all directions, outwards from the circle. If BC be drawn through the centre of O, parallel to the top and base of the cone, and if AD and XY be drawn equidistant from BC, then, provided regular reflection be presumed to occur as an average effect (compare *Phil. Mag.*, 1922, 43, 1054), it will readily be seen that of the molecules issuing from collision in circle O in any representative period of time, the ratio of the number of those crossing XY to the number of those crossing AD, however far (within free path distances) from BC these lines may be situated, will always be very considerably greater than the ratio of the length XY to AD (*Phil. Mag., loc. cit.* p. 1052).

If the gas is assumed to be initially of the same concentration throughout, and two dimensions only are being considered, then the number of molecules crossing these lines in any representative period of time will either be proportional to their lengths, or a change of concentration must occur. It has been shown that of the molecules proceeding from collision in circle O, an undue proportion will cross XY as compared with AD, and this is true (1) for all relative positions of AD and XY within free path distances from O, (2) for any and every position of O in the cone.

It follows, therefore, that molecules starting, with equal probability of motion in all directions, from collisions in the cone, will create a "condensation" or a disturbance of concentration towards the wider portion of the cone. The same effect may obviously be proved fully for three dimensions in a similar manner, and is really identical with that dealt with in the paper to which reference has been made, since

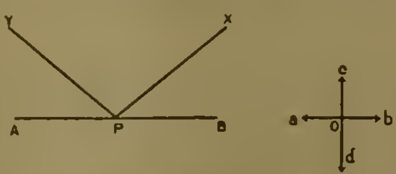

FIG. 2.

the whole cone is merely an extension of the one there described, sections ABCD and CDXY both being identical with the figure ABCD of the original paper.

Subsequent intermolecular collision in the cone cannot destroy the excessive downward bias so created, since this will merely be transferred to the other molecules concerned.

Fortuitous rebound from the walls, instead of regular "reflection," may be shown to lead to the same effect. If the wall AB be presumed to be ideally smooth, then a molecule approaching along path XP (Fig. 2) will be "reflected" along PY, receiving an impulse from the wall in the direction *oc*, the wall itself receiving the equal and opposite impulse in the direction *od*. If the wall be irregular, or owing to thermal oscillation, or adsorption, or many other causes, it may in addition exert an impulse on the molecule in the direction *ob*, receiving the equal and opposite impulse along *oa*, or it may exert an impulse along *oa*, receiving one along *ob*. Should the former lateral effect predominate, the directing effect of the cone will be *increased*; should the latter predominate the effect will be reduced, but there is no reason to suppose that, in any representative period of time, either will predominate over the other.

ARTHUR FAIRBOURNE.

King's College, University of London,
Strand, W.C.2.,
January 1.

Sir Isaac Bayley Balfour.

ALL botanists and lovers of flowers will mourn the death of the Edinburgh professor, who served science and horticulture as few men have ever done. The occasion seems opportune to relate an incident comparatively unimportant in itself but in a manner typical. Many years ago a beautiful Primula, called by Greene *P. rusbyi*, was discovered in the Mogollon Mountains of New Mexico. Later, in the Sandia Mountains of the same State, one of my students found an apparently distinct species, which I named *P. ellisiæ*. These primroses occupied distinct and isolated mountain ranges, but were so similar, at least in the herbarium, that a German writer pronounced them identical. No one, so far as could be learned, had seen more than one of them alive, and it was the living plants we needed to settle the matter. I was able to procure seeds of *P. ellisiæ* for Prof. Bayley Balfour, and in 1921, when my wife and I visited him in Edinburgh, he not only had *ellisiæ* in full flower, but also *rusbyi*, the seeds of which he had secured from some other collector. It was a dramatic moment when the Professor held the two pots, one in each hand, and pointed out that the plants were quite distinct. Thus, in Edinburgh, we learned a lesson in New Mexico botany, which we had never been able to learn when resident for years in that region. No doubt others could relate parallel experiences.

T. D. A. COCKERELL.

University of Colorado.

Age and Area in Natural Selection.

THE account in NATURE (December 2, vol. 110, p. 751) of the discussion at Hull on "The Present Position of Darwinism" has interested me greatly. Of course I realise that such an account must be summary and omit much that is said, but I am struck by the fact that apparently none of the speakers mentioned what seem to me two fundamental and even fatal objections to the Age and Area hypothesis as a subject for the theory of Natural Selection.

In the first place, the fact that "genus" is a very inexact term, largely dependent on the "personal equation," seems to be completely overlooked. Some of us tend to large genera, some to small. In his article in the *Nineteenth Century*, Dr. Willis refers to a genus of more than 1500 species. In my opinion, to call such a group a genus is positively grotesque; it includes probably scores of what I would call genera. I can juggle the genera of echinoderms (my own special group) so as to lend apparent support to the Age and Area hypothesis, or I can re-define them so as to contradict it strongly, and in either case I can quote high authorities or give excellent reasons for my course.

In the second place, the Age and Area hypothesis really explains nothing. It merely restates in a more or less tabular way what every taxonomist, who has given any attention to distribution, knows is often the case. I say "often" because, as some of those who took part in the discussion at Hull pointed out, there are many cases of distribution which do not fall in with this tabulated arrangement. No *causal* connexion between age and area is brought out in the proposed hypothesis. The only causal factors suggested are time and an inherent tendency to diversification, and surely both of these are given abundant play in the theory of Natural Selection.

I note with interest, perhaps I might say amusement, the statement by Mr. Cunningham that Natural Selection is "as extinct as the dodo." It may be in the land of its birth, but it is still very much in evidence in America. Nearly every systematic zoologist whom I know personally believes in it as a factor in evolution, though the importance attributed to it may vary greatly. Prof. E. G. Conklin of Princeton, certainly one of our foremost zoological thinkers, has just completed a course of Lowell Institute lectures in Boston on "The Revolt against Darwinism," in which he has most clearly and emphatically stated his strong conviction, not only that such revolt is unjustifiable, but that Natural Selection is the most important theory that has yet been proposed for helping us to understand adaptation. It surely seems a little rash to call Natural Selection, or anything else, "extinct" because it has disappeared from one's own horizon. Horizons contract with increasing near-sightedness.

HUBERT LYMAN CLARK.

Cambridge, Mass., U.S.A.,
December 22, 1922.

The Cause of Anticyclones.

MAY I be allowed to suggest that the region of an anticyclone finds its most likely interpretation as an area hemmed in by cyclone systems. I agree with Mr. Dines (NATURE, December 23, vol. 110, p. 845) that it is the mass of air over the area that is important. It is a matter of personal observation that, as Mr. Dines says, "the steady and persistently high barometric pressure that has prevailed over southern England during most of the autumn" has been associated with the overlapping high overhead *here* of the margins of cyclone systems that were simultaneously from west to eastwards on our north and on our south respectively. The phenomenon of contrary currents at *high* elevation is an inseparable feature, in my experience, of anticyclonic conditions.

May it not be a conditional factor of these anticyclonic high pressure areas (?) the "mass" of air being piled to excess and held *in situ* by the conflicting winds of over-reaching cyclone lips. The play of antagonistic forces of movement and of their accompanying contrasts of humidity and temperature may be answerable for all other anomalies of anticyclone areas. What are wanted are observations of winds of *highest* elevation, which are only to be obtained by the method of employing a projected telescopic image of the sun, which renders visible and legible the "wind-billows" of individual strata of movement.

CATHARINE O. STEVENS.

The Plain, Boar's Hill, Oxford,
January 16.

The Name of the Pond Snail.

IN NATURE for January 13, p. 49, two writers of authority call this snail *Limnæa peregra*. The word "peregra" is not Latin—a fact which at one time had penetrated to the consciousness of most conchologists and malacologists but appears to have been again forgotten.

F. A. B.

Medical Education.

I REGRET that I have not the time to do justice to Sir Archdall Reid's last letter, which is supposed to deal with the above subject (NATURE, January 13, p. 50). It is, as I expected, really an attempt to open up another discussion on evolution. Now since Sir Archdall confesses to having already spent eighteen months vainly trying to find out what biologists mean, it seems inadvisable to begin again; for his letter indicates a very imperfect acquaintance with biologists and their work.

To my mind it is an amazing suggestion that zoologists and botanists are incapable of teaching evolution, and it is illuminating indeed to find that men are to come after them "who have observed, with a minuteness and accuracy impossible to workers among plants and animals." I shall be glad to meet the gentlemen when they arrive. Meanwhile, until these Supermen appear, it is highly desirable that first-year medicals, raw youths from school, should make their first acquaintance with the animal world through less expensive material than human bodies, and should approach a great profession with, what practice and theory have shown to be, the best introduction.

W. J. DAKIN.

Department of Zoology, University,
Liverpool, January 17.

An Overlooked Feature in Four-legged Tadpoles of *Rana temporaria*.

ALL accounts of the metamorphosis of the common frog leave it to be tacitly inferred that when the front legs make their way through the operculum branchial respiration ceases, and that thenceforth breathing is effected by the lungs, skin, and mucous membrane of the mouth. It appears to have been entirely overlooked that from the time of the acquisition of free front legs until the tail is completely absorbed, and the little anurous frog leaves the water, branchial respiration continues, water being drawn through the nostrils into the mouth, and *discharged from the opercular chamber through a pair of crescentic apertures, one on each side immediately anterior to the base of the front leg.*

FIG. 1.—Ventral view of four-legged tadpole of *Rana temporaria* when absorption of tail is nearly completed. The arrows mark the exits of the water from the opercular chamber.

In July 1922 I was watching some tadpoles that had just acquired their front legs, and was keeping them in a shallow dish of pond water in which was a certain amount of suspended, finely divided solid matter. I observed that the tadpoles did not come to the surface of the water to breathe, but continued sitting at the bottom; and that the respiratory movements of the sides of the head were still proceeding in regular rhythm, but now were confined to the region posterior to the gape of the mouth, whereas prior to the appearance of the front legs the movements extended up to the extreme anterior end. Closer attention enabled me to detect minute solid particles occasionally entering the nostrils, and two fairly steady currents of water issuing from the posterior end of the head, one in front of the left and the other in front of the right leg.

On killing a few specimens I found a crescentic, slightly thickened lip bounding the anterior margin of each of these opercular openings, and was able to lift the flaps and pass bristles in at each, and out through the mouth, and conversely. This condition persisted until the absorption of the tail was completed.

Fearing that I might have encountered an abnormal family of tadpoles—they were rather unusually late in the season—I examined preserved specimens of which I have scores, collected years ago, in my laboratory for teaching purposes, and found exactly the same state of affairs in every one at this stage of development.

To make assurance doubly sure I had vertical longitudinal series of sections cut through four specimens; and these fully confirm the naked-eye observations.

I have little doubt that others have noticed the thickened crescentic lips of the two opercular apertures; for in a figure published by Milnes Marshall, and in another by Howes ("Atlas of Practical Elementary Zoology," 1902 ed., Pl. ix. Fig. xiv.) it is indicated. Probably it has hitherto been mistaken for a line of fusion between the body wall and the remnant of the operculum left after the front legs have penetrated it.

OSWALD H. LATTER.

Charterhouse, Godalming,
January 12.

Smell and Specific Gravity.

IN the course of some other experiments which are being undertaken in the Psychology Department of the University of Edinburgh, a number of subjects were requested to arrange in serial order, according to smell, phials containing oil of cedar (C), origanum (O), sandalwood (S), and terebene (T). Twenty-two experiments were made in all, and tend to confirm the observations made by Haycraft, Cohn, Zwaardemaker, Heyninx, and others, with regard to odour and chemical constitution.

The serial arrangement was made, not according to the affect (pleasantness or unpleasantness) nor to the intensity, but according to "pitch," or "heaviness and lightness," "dulness and sharpness" of the sensation. The number of votes cast for the position of each substance in the series was as follows:—

	1	2	3	4
S	16	4	1	1
C	4	11	4	3
O	2	6	10	4
T	...	1	7	14

A serial arrangement according to specific gravity is thus represented by the voting: sp. g. S = 0·974–0·980, C = 0·930–0·96, O = 0·890–0·90, and T = 0·862–0·868. In nine out of twenty-two experiments the series was arranged without any error. The number of cases in which three of the osmyls were placed correctly was as follows: SCO 10, COT 9, SCT 14, SOT 15. SC and OT were correctly placed relatively to each other in 17 instances, CO in 14, SO and CT 19, and ST (the two extremes) in 21 out of the 22 experiments.

The serial arrangement as recorded above is therefore by no means entirely due to chance, and the number of errors made diminishes the greater the difference between the specific gravities of the substances employed. As the above substances of the terpene group are not compounds but complex mixtures, moreover, as the subjects without any further explanation were only instructed to smell and arrange them in a series, the results are sufficiently striking.

J. H. KENNETH.

Edinburgh University,
January 10.

Greek Geometry, with Special Reference to Infinitesimals.[1]

By Sir T. L. HEATH, K.C.B., K.C.V.O., F.R.S.

GREEK geometry passed through several stages from its inception to its highest development in the hands of Archimedes and Apollonius of Perga. The geometry which Thales brought from Egypt early in the sixth century B.C. was little more than a few more or less accurate rules for the mensuration of simple figures; it was the Greeks who first conceived the idea of making geometry a science in and for itself. With Pythagoras and the Pythagoreans, who represent the next stage after Thales, geometry became a subject of liberal education. Apart from special discoveries such as those of the theorem of the square on the hypotenuse, the equality of the three angles of any triangle to two right angles, the construction of the five cosmic figures (the five regular solids), and the incommensurability of the diagonal of a square with its side, the Pythagoreans invented two methods which remained fundamental in Greek geometry, that of proportions (though in a numerical sense only) and that known as application of areas, which is the geometrical equivalent of the solution of a quadratic equation.

By about the middle of the fifth century the Pythagoreans had systematised the portion of the Elements corresponding to Euclid Books I., II., IV., VI., and probably III.

In the second half of the fifth century, concurrently with the further evolution of the Elements, the Greeks attacked three problems in higher geometry, the squaring of the circle, the trisection of any angle, and the duplication of the cube. Hippias of Elis first trisected any angle by means of his curve, the *quadratrix*, afterwards used to square the circle. Hippocrates of Chios, who also wrote the first book of Elements and a treatise on the squaring of certain lunes, reduced the problem of duplicating the cube to that of finding two mean proportionals in continued proportion between two straight lines, the first solution of which was by Archytas, who used a wonderful construction in three dimensions. Democritus, among many other mathematical works, wrote on irrationals; he was also on the track of infinitesimals, and was the first to state the volume of any pyramid and of a cone.

The fourth century saw the body of the Elements completed. Eudoxus discovered the great theory of proportion set forth in Euclid Book V. and the "method of exhaustion" for measuring curvilinear areas and solids. Theætetus contributed to the content of Book X. (on irrationals) and Book XIII. (on the five regular solids). This brings us to Euclid (*fl.* about 300 B.C.).

To the third century B.C. belong Aristarchus of Samos, who anticipated Copernicus; and Archimedes, who, with Apollonius following after twenty years or so, concludes the golden age of Greek geometry.

To come to the history of infinitesimals. The Pythagoreans discovered the incommensurable and maintained the divisibility of mathematical magnitudes *ad infinitum*. The difficulties to which the latter doctrine gave rise were brought out with incomparable force by Zeno in his famous Paradoxes and in other like arguments. Zeno's Dilemmas profoundly affected the lines on which mathematical investigations developed. Antiphon the Sophist, in connexion with attempts to square the circle, declared that by inscribing successive regular polygons in a circle, beginning with a triangle or square and continually doubling the number of sides, we shall ultimately arrive at a polygon the perimeter of which will coincide with that of the circle. Warned by Zeno's strictures, mathematicians denied this and substituted the statement that by following the procedure we can draw an inscribed polygon differing in area from the circle by as little as we please. Similarly they would never speak of the infinitely great or infinitely small; they limited themselves to postulating that by continued division of a magnitude we shall ultimately arrive at a magnitude smaller than any assignable magnitude of the same kind, and that by continual multiplication of any magnitude however small we can obtain a magnitude exceeding any assignable magnitude of the same kind however great. On this safe basis Eudoxus founded the whole of his theory of proportion and the method of exhaustion.

It has been remarked that the method of exhaustion, though a conclusive method of proof, requires previous knowledge of the result to be proved, and is of no use for discovering new results. This is scarcely true because, before the proof by *reductio ad absurdum* is applied, the area or volume has to be *exhausted*, and this process often indicates the result. The process means a summation of a series of terms; and there are different classes of cases according to the nature of the series to be summed. In one case (Archimedes' quadrature of a parabolic segment) the summation is that of the geometrical progression $1 + \frac{1}{4} + (\frac{1}{4})^2 + \ldots$. Archimedes sums this, nominally, to n terms only. He says nothing about taking the limit when n is increased indefinitely, but merely declares that the area of the segment, which is actually $A\{1 + \frac{1}{4} + (\frac{1}{4})^2 + \ldots \textit{ad inf.}\}$, is $\frac{4}{3}$ A, where A is the area of a certain triangle. It seems plain, nevertheless, that Archimedes found his result by mentally taking the limit. Other series summed by him are arithmetical progressions and the series of the squares of the first n natural numbers. In these cases Archimedes sums two series representing respectively figures circumscribed and inscribed to the figure to be measured, and then states a certain intermediate quantity to be the actual area or content required. Here again Archimedes, though he does not say so, states what is in fact the common limit of the two sums when the number of terms in the series is indefinitely increased, and a factor common to all the terms is at the same time indefinitely diminished. The result is actually equivalent to integration. There are some six cases of the kind depending on the integrations $\int x dx$, $\int x^2 dx$, $\int (ax + x^2) dx$ and $\int \sin\theta d\theta$ taken between proper limits respectively.

The reasons why the Greeks were so limited in the number of integrations which they could directly effect were that they had no algebraical notation and

[1] Abridged from the presidential address to the Mathematical Association, January 2.

had not discovered the modern developments of certain functions as series; nor had they discovered that differentiation and integration are the inverse of one another. There is little trace in Greek geometry of considerations corresponding to the differential calculus: the only case that seems certain is that of the subtangent property of a spiral which must have been obtained by the consideration of the instantaneous direction of motion, at any point on the curve, of the point describing it. If, as is probable, Apollonius, in his treatise on the *cochlias* or cylindrical helix, dealt with tangents to the curve, he would no doubt determine the direction of the tangent at any point in the same way.

But the Greeks were by no means limited to what they could obtain by direct integration. They were very ingenious in reducing an integration which they could not perform directly to another the result of which was already known. This must have been the method by means of which Dionysodorus found the content of an anchor-ring or tore and Pappus obtained his theorem which anticipated what is known as Guldin's theorem. In the matter of the anchor-ring the Greeks also anticipated Kepler's idea that the content is the same as if the ring be conceived to be *straightened out* and so to become a cylinder. The Method of Archimedes is mostly devoted to the reduction of one integration to another the result of which is known, but is remarkable also as showing how he obtained certain results otherwise proved in his main treatises. The method was a mechanical one of measuring elements of one figure against elements of another, the elements being expressed as parallel straight lines in the case of areas and parallel plane sections in the case of solids. This point of view anticipated Cavalieri. The elements are really infinitesimals, indefinitely narrow strips and indefinitely thin laminæ respectively, though Archimedes does not say so. But Archimedes disarms any criticism that could charge him with using infinitesimals for proving propositions by carefully explaining that the mechanical procedure does not constitute a proof and is only useful as *indicating* the results, which must then, before they are definitely accepted, be proved by geometrical methods, that is, by the method of exhaustion.

The Disappearing Gap in the Spectrum.[1]

By Prof. O. W. Richardson, F.R.S.

II.

Turning to Fig. 1, B, which is repeated here for convenience of reference, this shows the various outposts where from time to time spectral lines have been located. It will be seen that there is still a considerable gap between 16·35, the limit obtained with the vacuum grating at the L series of aluminium, and 17·39, the limit with the crystal spectrometer at the L series of zinc. Between these limits no spectral lines are known, but there is evidence of the excitation of such lines, and data have been obtained for the high-frequency limits of spectra in this region.

This evidence depends upon considerations of a somewhat different character from those dealt with so far. If we consider any typical characteristic X-radiation of an element, for example, the K-radiation, it is found to consist of a number of spectral lines which are denoted by the symbols K_α, K_β, K_γ, in order of ascending frequency. In general there are more than three lines, but we shall adopt the symbol K_γ for the line of highest frequency which is observed, and we

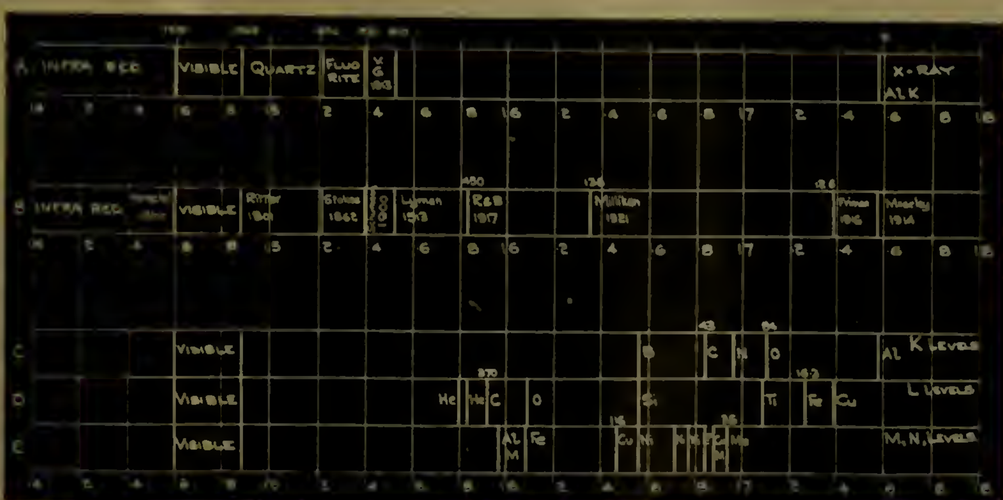

Fig. 1.

shall denote its frequency by ν_{K_γ}. These lines can be excited in an element by a stream either of high-frequency radiation or of high-velocity electrons reaching it. In either case the lines are not excited separately, but the whole group K_α-K_γ appears simultaneously. It is found that there are simple and important restrictions on the radiation frequencies and on the electron energies which are capable of

[1] Continued from p. 121.

exciting these lines. Thus it is found that there is a critical radiation frequency ν_c, which is very nearly equal to, but just greater than, ν_{K_γ}, and unless the incident radiation stream contains components the frequencies of which are at least as great as ν_c, the K series will not be excited. There is a precisely analogous limitation on the electron energies which cause the generation of the characteristic radiations. Thus there is a critical electron energy eV_c, where V_c denotes the critical potential difference through which the electron of charge e has to fall in order to gain this energy, which is connected with the critical frequency ν_c by the quantum relation $eV_c = h\nu_c$, and if the energy of the impinging electrons is equal to, or greater than, eV_c, the characteristic radiations will be excited, otherwise they will not. Furthermore, if we measure the absorption of radiations of different frequencies by the element under consideration, we find that, corresponding to the excitation of the characteristic rays, there is a sudden increase in absorption at the critical frequency ν_c. There is also a discontinuity in the ionisation of the element at the same frequency.

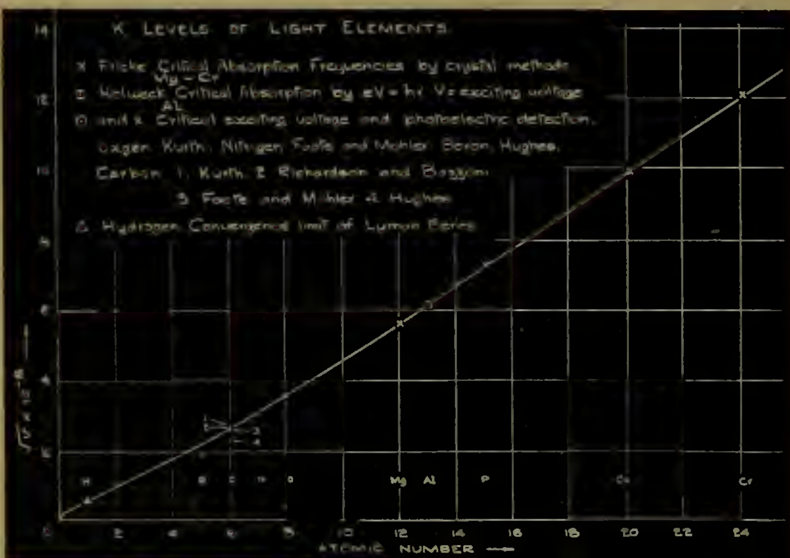

Fig. 4.

There is definite evidence from X-ray phenomena that the critical energy eV_c measures the work which has to be done in removing an electron from its position in the normal atom to a point outside the atom. The characteristic rays are emitted when the gap thus created is subsequently filled up, the different lines arising according to the origin of the electron which fills the gap. If, measured in terms of energy, it is from a near location, we get a low-frequency line such as K_α; if it is from a location near the surface of the atom, a high-frequency line such as K_γ arises.

Thus critical energies such as eV_c give a direct measure, in terms of energy, of the *levels* of the different electrons in the atom. Alternatively, the corresponding critical frequencies ν_c are the *limits* of the relevant X-ray spectra. If we can determine these limits we shall have found the high-frequency ends of the various spectra. While these ends are not, strictly speaking, spectral lines, for the heavier elements at any rate, they are very close to the highest-frequency emission lines in the spectra. Furthermore, according to modern spectroscopic theory, they give us the fundamental data on which the formulæ for the spectral series are based.

It is a curious fact that evidence of the existence of such levels in the gap between what are ordinarily termed the X-ray and the ultra-violet spectra should have been produced independently and almost simultaneously by a number of investigators scattered all over the world. These include Foote and Mohler in Washington, Holtsmark in Christiania, Holweck in Paris, Hughes in Kingston, Ontario, Kurth in Princeton, and myself and Bazzoni in London. While the details of the apparatus used by the different workers vary considerably, the principle involved in most of them can be made clear by reference to Fig. 2 (p. 119). Let the element under test forming the anode A_1 be bombarded by a powerful electron current from the hot cathode F. Then any radiation generated at A_1 can pass between the charged plate condenser P, where any ions present will be removed from it, into the chamber on the left. If the rather complicated apparatus shown in the left-hand chamber is removed and replaced by a plate on which the radiation falls and by a second electrode, the radiation can be detected by the photoelectric electron emission it produces at the plate and measured by the current which flows between the two electrodes, the plate being negatively charged. Let this current be measured and divided by the thermionic bombarding current for a series of different potentials applied between F and A_1; then if there is a sudden generation of characteristic rays from A_1 at some critical potential V_c we should expect an increased rate of rise of the photoelectric current with applied potential to set in at V_c. Thus, briefly stated, the experimental method is to plot photoelectric current per unit thermionic current against primary bombarding potential and to look for discontinuities in the resulting diagram. These discontinuities should occur at the critical potential differences V_c corresponding to the energy levels eV_c and to the frequency limits ν_c equal to eV_c/h.

This general type of method leaves much to be desired, but it seems the most practicable procedure at the present stage of the subject. It is open to the general objection that discontinuities in functional diagrams are often merely indications of faulty experimenting, and the evidence that such discontinuities as are observed are really due to the excitation of X-rays is quite indirect and inferential. It is hoped later, however, to make good this deficiency by supplying a direct test of the frequencies of the radiations generated; for example, by using the magnetic spectroscope which was used for determining the end of the helium spectrum, and by other methods.

Fig. 4 shows the square roots of the critical frequencies of the light elements for K-radiations plotted as ordinates against the atomic numbers as abscissæ. The values for all the elements from magnesium to chromium which are amenable to crystal methods have been determined accurately with crystal gratings by Fricke, who measured the wave-length at the absorption discontinuity. They all lie on a curve which is almost a straight line through the origin, and a few of them are shown thus, x. The aluminium value ⊡ is practically identical with Fricke's for the same element and was obtained by Holweck by measuring the voltage V_c on an X-ray tube for which the absorbability in aluminium of the total radiation is a maximum. This method contains features which, though found separately in the method used by Fricke and in the photoelectric methods, are not common to both, and the agreement will no doubt tend to promote confidence in the photoelectric methods. The points for oxygen (Kurth), nitrogen (Foote and Mohler), carbon (Foote and Mohler, Hughes, Kurth, Richardson and Bazzoni), and boron (Hughes) have all been obtained by photoelectric methods. The hydrogen point △ is the limit of the Lyman series which should correspond to the K level for hydrogen. It will be seen that the hydrogen, nitrogen, and oxygen points practically fall on a smooth curve which is continuous with the curve for the elements from magnesium to chromium. There is some disagreement in the case of carbon, but three of the points are very close to the same curve. The only notable deviation is the low value given by Hughes. The boron value also falls below this curve but there is, so far as I am aware, no known reason why the frequencies should be a smooth function of atomic number for these very light elements.

The next lower critical frequency for any element will presumably be that pertaining to the L group, or the highest L critical frequency if there is more than one. The square roots of a number of such critical frequencies for elements from boron to copper as given by photoelectric methods (boron and carbon, Hughes; carbon, oxygen, aluminium, silicon, titanium, iron, and copper, Kurth) are shown thus, x, in Fig. 3 (p. 120). These frequencies should be somewhat higher than those of the corresponding lines, and it will be seen that the observed points from aluminium to copper are all about the same distance above the broken projection of the curve through the values for the L_{a_1} lines for the elements from zinc to zirconium obtained by crystal measurements. This affords additional justification for extrapolating from the zirconium to zinc L_{a_1} values to the value for the L_a line for aluminium as was done in interpreting Millikan's vacuum grating data. It will also be observed that the values of the limits for boron, carbon, and oxygen given by the photoelectric methods are either very close to the values for the shortest lines in the L spectra found by Millikan or have a somewhat higher frequency. These properties are in harmony with those found in what is more usually regarded as the X-ray region. It should be added that data for elements between sodium and chlorine have been given by Mohler and Foote, which fall on or below the L_a curve as drawn in Fig. 3. These data, however, have been obtained by the electron bombardment of vapours, in many cases of compound vapours, and it is not improbable that the values for these will be different from those for the solid elements. Some of these data also appear to refer to radiation potentials, which correspond to lines, rather than to ionisation potentials, which correspond to limits.

Just as in the case of the L_a lines, the L limits for the light elements from helium to magnesium do not change smoothly with increasing atomic number as do the limits for the heavier elements. In fact the frequency for helium as obtained either by direct determination of the end of the corresponding spectrum or from the ionising potential is higher than that of succeeding elements until carbon is reached.

In the case of a number of elements ranging from aluminium to molybdenum, critical potentials have been observed (by Kurth and by Richardson and Bazzoni) at values corresponding to frequencies well below those which characterise the L spectra. The connexion with the generally recognised X-ray series of the heavier elements has scarcely yet been worked out in sufficient detail for the precise group allocation of some of these to be determined with certainty.

Turning to Fig. 1, C, D, and E show, on the same scale as in A and B, the position of some of the spectral limits given by these photoelectric methods. It will be seen that a majority of them lie in the gap between 16·35 and 17·38 in which so far no spectral lines, either X-ray or ultra-violet, have been detected by grating methods. If the interpretation of these photoelectric determinations as the ends of the various spectra is substantiated, it will have to be admitted that the gap in the spectrum between the ultra-violet and the X-ray region about which I have been speaking is not merely disappearing but has actually disappeared.

Obituary.

Prof. Johannes Orth.

PROF. JOHANNES ORTH, whose death is announced, was born in 1847 at Wallmerod in Nassau. He received his medical and scientific training chiefly at Bonn, where he studied pathology under Rindfleisch, whose assistant he afterwards became. Later, he was appointed assistant to Virchow in Berlin. In 1878 he was appointed professor of general pathology and pathological anatomy in Göttingen and afterwards received the title of *Geh. Med.-Rat.* In 1902, on the death of Virchow, he was elected to the chair of pathology in the University of Berlin, and since then his energies have been devoted chiefly to the development of the Institute of Pathology, which was founded and equipped by Virchow.

Orth was the author of numerous papers on pathological subjects, and also of several books, the two most important of which were his "Compendium der pathologisch-anatomischen Diagnostik," which was translated into English in 1878, and his "Lehrbuch der speciellen pathologischen Anatomie," published in 1893. Orth was undoubtedly a pathologist of great eminence and made many valuable contributions to his subject, but his reputation rested rather on his powers as a teacher and expositor and on his width of knowledge than on any discovery in a special department. He was essentially a disciple of Virchow and a follower of his methods.

Mr. E. W. Nelson.

The science of oceanography and the scientific study of fisheries have lost a devoted and able worker by the tragic death of Mr. E. W. Nelson, the scientific superintendent of the Fishery Board's marine laboratory at the Bay of Nigg near Aberdeen, who was found dead in his laboratory on the morning of January 17. He had been appointed in September 1921 to succeed Dr. T. Wemyss Fulton in the service of the Fishery Board for Scotland, and he was proving himself a very effective investigator of Fishery problems. He was much liked and respected by his staff, and every one was looking forward to the work that he would do, especially as regards the physical conditions of the sea in their relation to fisheries, for it was in the bearings of physics on biology that he was most interested. He had an ingenious mind, more of the mathematical than of the biological order; though he was a keen naturalist as well. He was particularly well suited for the post that he held and he seemed to be very happy in his work.

Mr. Nelson was educated at Christ's College, Cambridge, and he was working at Plymouth Biological Station when he was chosen in 1910 to be a biologist to the British Antarctic Expedition led by Capt. Scott. He made an elaborate biological survey around the Cape Evans station, and Scott speaks in his "Journals" very appreciatively of his enthusiasm, carefulness, and practical ingenuity. Mr. Nelson was one of the thirteen men who stayed at Cape Evans for a third year under the command of Surgeon Atkinson. During the war Nelson served in the Royal Naval Division.

Mr. Nelson was a pleasant and cheerful personality, very kindly, though fond of an argument, very keen about his own work, but delightfully willing to help others, not wearing his heart on his sleeve, but full of good-will.

Dr. Talfourd Ely.

Dr. Talfourd Ely, whose death was recently announced at the age of eighty-six, was a nephew of Frank Ely, the dramatist, and great-nephew of Sir T. N. Talfourd, author of "Ion." During the greater part of his life he was closely connected with University School and College, London. He was vice-principal and classical tutor at University Hall, classical master at University College School, and secretary of the College. This last post he resigned in order to study archæology at Berlin, where he worked with Ernest Curtius, Kirchof, Robert, Furtwängler, and Waltenbach, and became acquainted with other leading scholars. He travelled largely in Europe, and had an exciting adventure at Olympia with brigands whom he routed. In his later years he was connected with many learned societies—the Antiquaries, Hellenic, Royal Archæological, and others. The literary works by which he will be best known are "A Manual of Archæology" and "Roman Hayling," embodying the results of his own excavations at Hayling Island, besides many papers on archæology.

The death of Miss Charlotte Sophia Burne has left a gap in the ranks of English students of folklore. A native of Shropshire, she edited with additions the collections of Miss G. F. Jackson, which were published under the title of "Shropshire Folklore," one of the best local manuals. Her later years were spent in London, where she became a pillar of strength to the Folklore Society, serving on the council and as president. In 1914 the Society published her admirable "Handbook of Folklore," but the main work of her later days was the collection of a great mass of materials for a new edition of John Brand's "Observations on Popular Antiquities," which was intended to become an encyclopædia of English folk beliefs. When her health broke down the task of editing this work was undertaken by Dr. E. Sidney Hartland.

Current Topics and Events.

The centenary of the death of Edward Jenner on January 26, 1823, was celebrated by the Academy of Medicine in Paris on Tuesday, January 23. At 3 p.m. a large meeting was held at the Academy in the Rue Bonaparte, when the president, M. Chauffard, gave a short address, which was followed by a long, critical, and yet eulogistic speech by M. Lucien Camus, and by communications on the subject of vaccination in detail from MM. Pierre Teissier, Jeanselme, d'Espine, and Sir St. Clair Thomson. The fine large hall of the Academy was crowded, the French Minister of Health, M. Strauss, and Madame Curie being present, in addition to other distinguished people. The busts of Jenner and Pasteur were placed on the right and the left of the platform. After the ceremony a number of mementoes of Jenner in the form of letters by him, and of old cartoons commemorating or deriding vaccination, were shown in one of the halls of the Academy. The president announced that communications in honour of the event had been received by him from learned societies in many parts of the world. Sir Ronald Ross, a foreign associate of the Academy, who represented the British Ministry of Health, handed in also a letter from the president of the Royal Society, and other British societies were represented by Sir St. Clair Thomson and by Dr. R. O. Moon. Sir Almroth Wright, another foreign associate of the Academy, was also present. After the ceremony the president and council of the Academy, in honour of the commemoration, gave a dinner at the Club de la Renaissance Française.

By the will of the late Prof. Emil Chr. Hansen, director of the Physiological Department of the Carlsberg Laboratory, Copenhagen, and his wife, a fund bearing his name was established in 1911 providing for the award on Prof. Hansen's birthday, May 8, at intervals of about two or three years, of a gold medal bearing his effigy, and accompanied by a sum of at least 2000 kroner, to the author of a distinguished publication on some microbiological subject that has appeared in recent years in Denmark or elsewhere. The medal was awarded in 1914 to Dr. Jules Bordet, Brussels, for researches in medical microbiology, and in 1922 to Dr. M. W. Bejerinck, Delft, for researches in general microbiology. This year it is proposed to award the medal to an author of experimental researches in marine microbiology. The award is made by a committee consisting of the Danish trustees of the fund together with at least two foreign microbiologists. The committee is composed this year of Prof. C. O. Jensen, director, Serum Institute of the Royal Veterinary and Agricultural College, Copenhagen; Dr. Johs. Schmidt, director, Physiological Department of the Carlsberg Laboratory, Copenhagen; Prof. S. P. L. Sörensen, director, Chemical Department of the Carlsberg Laboratory, Copenhagen; Prof. H. H. Gran, University of Christiania, Norway, and Prof. C. A. Kofoid, University of California, Berkeley, U.S.A. Further particulars may be obtained from the president of the Board of Trustees, Emil Chr. Hansen Fund, Copenhagen (Valby).

The question of training in Illuminating Engineering was discussed at the last meeting of the Illuminating Engineering Society, an introductory paper being read by Mr. C. E. Greenslade and Mr. J. E. S. White. The authors discussed in some detail the planning of courses on illumination at technical colleges, pointing out that special attention should be given to practical applications of light, and that the aspects of lighting considered by architects should be dealt with besides purely technical matters. It was also suggested that occasional popular lectures on the subject would be helpful, and that such lectures would be particularly useful in schools, so that children might grow up with an appreciation of the benefits of good lighting. It was pointed out that there is a need for a suitable text-book for students as most of the works available are somewhat elaborate, and that hints to lecturers on demonstrations and series of suitable lantern slides would also be valuable. The discussion was opened by Dr. F. T. Chapman, of the Board of Education, who suggested methods of improving the treatment of illumination in existing courses, and Mr. Gaster mentioned that the Society had issued a circular to technical colleges offering the co-operation of the Illuminating Engineering Society in the framing of syllabuses and, if necessary, the provision of lecturers. In almost all cases replies received had welcomed co-operation of this kind.

The presidential address of Capt. H. Riall Sankey to the Institute of Industrial Administration on "Training for Administration in Industry," which was delivered on October 10 last at the London School of Economics, has recently been published in the number of the *Journal of Industrial Administration* for Nov.-Dec., 1922. It gives a brief review of the work of the Institute, and also contains the announcement that, at the instance of its advisory council, the Institute has prepared an examination scheme with the view of the award of diplomas and certificates in connexion with subjects bearing on the administrative side of the work in industry. The scheme is shortly to be put into force, when it is proposed to hold examinations in eight groups of subjects, namely: (1) design, specifications, and inspection; (2) factory planning and plant management; (3) estimating, production methods, and rate fixing; (4) production control (scheduling and regulation); (5) employment administration; (6) materials and purchasing; (7) stores and transport management; and (8) production statistics and costing. The examination questions will be framed in relation to the administrative, in contradistinction to the strictly technical, aspects of the subjects enumerated above. Honours and pass certificates will be issued for each group of subjects, and it is intended at a later date to award diplomas to those who hold the qualifying number of certificates (the precise number has not yet been determined).

An article which appears over the initials H. B. in *Le Temps* of January 2, discusses the findings of the International Commission which, in September last, visited the sites at Ipswich on which Mr. Reid Moir claims to have found evidence for Tertiary Man. The investigations of the International Commission, which consisted of MM. Lohest, Fourmarier, Hamal-Nandrin and Fraipont (Belgium), MM. Capitan and Breuil (France), Messrs. MacCurdy and Nelson (U.S.A.), and Messrs. Reid Moir and Burkitt, afforded an exceptionally favourable opportunity for a careful examination and discussion of the evidence. The findings of the Commission, therefore, must carry great weight. According to the writer in *Le Temps*, the report presented to the International Institute of Archæology in Paris stated that the members of the Commission were unanimously of the opinion that Mr. Reid Moir's specimens from the base of the "Crag" were genuine artifacts and were found in deposits which were undoubtedly undisturbed, and belonged, beyond question, to the Upper Pliocene. After a careful examination of the characteristics of the specimens, in the course of which all giving rise to any doubt were set aside, the Commission held that they could have been produced by no natural cause and that their distinctive features were comparable with those of Mousterian implements about which there was not the least doubt. The writer concludes that we must inevitably accept the existence of man at Ipswich in the Pliocene period of the Tertiary epoch,—possibly not man himself as such nor even a direct ancestor, but a being who, in virtue of this industry, merits a place in the *genus homo* among the precursors of man; and that the evidence carries back the first appearance of this being on the globe well beyond the 125,000 years at which Osborn dates the beginning of the Pre-Chellean Age.

The annual report of the National Union of Scientific Workers shows that the Union has increased its membership to 826 with a corresponding improvement in its financial position. The formation of three special sections with activities connected with Government service, with industrial service, and with universities is probably a step in the right direction. In the first service there is stated to be profound dissatisfaction, partly due to the inadequate position, responsibility and freedom of initiative of scientific workers and partly to the operation of the "Geddes Axe." It is suggested that at the bottom of the discontent of scientific officers in Government departments is the totally inadequate understanding of science by officials, holding executive positions, originally appointed to the Civil Service on examinational efficiency in every side of education but science. The University Section would seem to have a definite function in respect to the teaching, pay, position, and free research hours of university teachers; it seems doubtful policy to merge it into a general education section to consider the whole "tree" from the infants' school to the universities. The Industrial Section has to deal with such matters as the pay, position, and unemployment of scientific workers in industry; the problems are so intricate that any standardising and grading of salaries as well as of the qualifications of those employed would seem impossible. Success is probably bound up with propaganda as to the important economic results likely to ensue from the due employment of properly qualified scientific workers in various sides of economic life. We note in this connexion the amalgamation, so far as their aims are concerned, of the Union with the British Association of Chemists and its friendly co-operation with many other professional bodies.

THE announcement has been made of a gift of 5000*l*. by a donor, who at present wishes to remain anonymous, to the Rowett Research Institute for Animal Nutrition at Aberdeen. This sum is intended to found a library and to provide for making statistical records.

A LECTURE on "Intersexuality and the Determination of Sex" will be delivered by Prof. Goldschmidt, of Berlin, in the Zoology Department, University of Liverpool, on February 15, at 7.30 P.M. An open invitation is extended to all who are interested. Further information can be obtained from Prof. W. J. Dakin, University, Liverpool.

NOTICE is given by the Iron and Steel Institute that the council of the Institute is prepared to consider in March applications for grants from the Carnegie Fund, in aid of research work on some subject of practical importance relating to the metallurgy of iron and steel, or allied subjects, and that special application forms may be obtained from the Secretary of the Institute. The results of research work must be communicated in the form of a report.

A JOINT dinner, to be called the "Ramsay Chemical Dinner," arranged by the Society of Chemical Industry, the Institute of Chemistry, the Society of Dyers and Colourists, the Glasgow University Alchemists' Club, the Andersonian Chemical Society, and the Ardeer Chemical Club, will be held in Glasgow on Friday, February 23. The dinner will take the place of the social functions previously held separately by the various societies in Glasgow and, it is hoped, will promote recognition of the importance of chemistry. Application to attend must reach Dr. J. A. Cranston, Royal Technical College, Glasgow, not later than February 16.

WE have received a copy of a list of the products manufactured by the British Dyestuffs Corporation Ltd., which is made up in the form of a diary. Classified lists of dyes, colours for special purposes, such as soap, film, and foodstuff colouring, are given, and lists of chemicals for research work (under the heading Association of British Chemical Manufacturers), microscopic stains, and indicators, are included. The volume is very convenient, and is a welcome indication of the progress made in the synthetic chemical industry.

THE second course of training for seed analysts will commence in July at the Official Seed Testing Station, Cambridge, and will last four to five weeks. The course is limited to those who are nominated by seed firms, recommended by universities or agricultural colleges, or otherwise show their fitness for such training. At the conclusion of the course, an examination is held which is also open to nominated candidates who have not taken the course of instruction. Applications must reach the Secretary, National Institute of Agricultural Botany, by May 1 next.

THE following lecture arrangements of the Royal College of Physicians of London have been made: Dr. W. G. Savage will deliver the Milroy Lectures on February 22, 27, and March 1. The subject will be "Canned Foods in Relation to Health." The Goulstonian Lectures will be given by Dr. G. Evans on March 6, 8, and 13. The subject will be "The Nature of Arterio-Sclerosis." Dr. A. J. Hall will deliver the Lumleian Lectures on March 15, 20, and 22, taking as his subject "Encephalitis Lethargica (Epidemic Encephalitis)." The lecture hour in each case will be 5 o'clock.

MR. G. A. DUNLOP, keeper of the Warrington Museum, sends his report for the two years ending June 30, 1922. During the latter year the number of visitors amounted to 82,815, being an increase of more than 50 per cent. as compared with the previous year. We infer that the increase consists largely of children, since a serious attempt has been made to bring about a closer connexion between the schools of the town and the museum. A special advisory committee has suggested a scheme for the utilisation of the museum in the teaching of general and local history to the school children. Unfortunately the scheme is not given in the report.

MESSRS. H. F. AND G. WITHERBY announce for publication this month "A Biology of the British Hemiptera-Heteroptera," by E. A. Butler. The work will include a complete list of British families, subfamilies, genera, and species, arranged according to Oshanin's "Katalog" (1912), and many illustrations.

A LIST (No. 31) of second-hand books of science, mainly natural history, botany, and gardening, has just been issued by Mr. R. S. Frampton, 37 Fonthill Road, N.4. Upwards of a thousand titles are given, and the prices asked appear very reasonable.

THE latest catalogue (No. 439) of Mr. F. Edwards, 83 High Street, Marylebone, W.1, is devoted to atlases and maps and books of geographical interest. As is usual with the catalogues issued by this bookseller, the present list contains many rare and scarce items, which are fully described.

MR. E. G. WHITE, the third edition of whose "Voice Beautiful in Speech and Song" was noticed in NATURE of December 30, p. 871, objects to the remark of the reviewer "that I regard the vocal cords 'as strings,' whereas the whole book is written for the precise purpose of showing that they are not strings." In stating that Mr. White regards them as strings the reviewer adopted the argument in Chapter III. of the book, but he did not say that Mr. White actually believed the "vocal cords" to be strings. As to the view that the theory of sinus tone production "is not supported by a particle of evidence," Mr. White refers to evidence "that it is possible to speak and sing when both vocal cords have been excised," but no physiologist would accept this as conclusive. He detaches from the notice of the second edition of his book, in NATURE of April 17, 1919 (vol. 103, p. 124), the words "there is much to admire in this book," but omits to add that the reviewer "J. G. M." entirely rejected his thesis, remarking, "Over and over again he furnishes what he regards as evidence in support of his thesis, but the conclusion, almost invariably, is in the opposite direction." To this it may be added that the supposed evidence never points in the direction of the sinuses.

Our Astronomical Column.

CALENDAR REFORM.—Somewhat of a deadlock has been reached in the matter of calendar reform, owing to the unwillingness of a considerable section to abandon the free week, which has now been running uninterruptedly for some 3000 years, by the introduction of days that would not count in the week or month. Rev. D. R. Fotheringham, editor of the *Chaldaean*, proposes a scheme in No. 17 of that journal which would retain the fixed calendar, without interfering in the least with the succession of weekdays. He proposes to make an ordinary year exactly 52 weeks or 364 days. This could be divided into 4 quarters, in each of which the lengths of the months would be 30, 30, 31 days; or if preferred, there could be 13 months of 4 weeks each: every fifth year (the last digit of which was 0 or 5) would have an extra week; unless the year was divisible by 45, in which case there would be no extra week. There would thus be 8 extra weeks in 45 years, the average length of the year being 365·2444444 . . . days. The true length of the tropical year is 365·242199, so that the error is 0·00224 days, or 1 day in 446 years; this is a trifling amount and could be corrected by dropping the extra week once in 3000 years, in addition to its normal dropping every forty-fifth year. The proposed calendar would satisfy the following desiderata, assuming that the extra week is always reckoned at the end of the year: (1) any particular calendar date would always be on the same day of the week; (2) the interval in days between two dates in the same year would always be the same; (3) the fact of the sequence of weekdays going on unchanged would be likely to remove opposition from ecclesiastical and other quarters. The two chief objections to our present system from the astronomical point of view are the irregular lengths of the months, and the occurrence of the leap-day early in the year. The latter flaw is not due to Julius Caesar, for he made March the first month, as the prefixes Septem-, Octo-, etc., still remind us; so that he saw the advantage of putting the leap-day at the end.

THE POSITION OF THE SOLAR APEX.—The positions derived for the solar apex, or point to which our system is tending, from the study of the stellar proper motions, have been far less accordant than one could wish; it has been found indeed that they differ systematically according to the faintness of the stars the motions of which are utilised. The late Prof Kapteyn suggested that this discordance might be due to the imperfect correction of systematic errors in the older catalogues; this would affect the proper motions deduced from comparison of these catalogues with modern ones, and the effect on the position of the apex would be greatest for the stars with smallest motions. Now a determination of the apex from the radial velocities of stars is independent of this source of error, and is therefore a useful check. M. J. S. Paraskevopoulos, of Athens Observatory, uses the radial velocities of the stars in Voûte's Catalogue, together with 537 additional ones recently published from Victoria, B.C. His results, given in *Astr. Journ.* No. 813, are:—

	North Stars.	South Stars.	All Stars.
R.A. of Apex	$271°·4$	$272°·2$	$271°·6 \pm 3°·0$
N. Decl. of Apex	$31°·6$	$29°·6$	$30°·3 \pm 3°·0$
Sun's velocity km./sec.	$20°·7$	$25°·4$	$23°·33 + 1°·03$

The apex accords well with that usually adopted, but the velocity is somewhat greater.

LOST PLANET RECOVERED.—Planet 132, Aethra, was discovered by the late Prof. Watson of Ann Arbor on June 13, 1873 It was one of 22 found by him between 1863 and 1877; he was not content merely with finding them, but he also determined their orbits and perturbations, and at his death left a trust fund to secure that the necessary calculations and observations should continue to be made on these planets after his death. Aethra appeared to be the most interesting of them all from its large eccentricity and small perihelion distance; however, in spite of constant endeavour it remained lost from 1873 till now. On December 12, 1922, M. B. Jekhowsky, of Algiers Observatory, found a planet of mag. 10·5 in R.A. 5^h $56·1^m$, N. Decl. 18° 27′ with daily motion $-1·3^m$, S. 21′. It was independently found at Simeis on December 19 by M. G. Beljavsky. An approximate orbit by M. Jekhowsky makes it highly probable that it is the lost Aethra, a conclusion which Dr. Luther has reached independently. As further observations are desired, the following predicted positions (from *Astr. Nach. Circular*) may be useful. January 24, R.A. 5^h $11·5^m$, N. Decl. 4° 33′; February 1, R.A. 5^h $10·6^m$, N. Decl. 3° 0′. The period comes out as 3·89 years if we assume 13 revolutions since 1872, but the assumptions of 12 or 14 revolutions would give $4·2^y$ and $3·6^y$ respectively. The elements deduced in 1873 were: Period 3·926 years, eccentricity 0·3314, perihelion distance 1·664, longitude of perihelion 151° 56′, ascending node 259° 40′, inclination 23° 42′.

Research Items.

Deciphering Charred Documents.—Mr. Raymond Davis, of the Bureau of Standards, Washington, finds that the written and printed matter of papers that have been thoroughly charred, as, for example, by being heated in an iron box or safe, may be deciphered by placing the charred sheet in contact with a fast or medium plate for a week or two in the dark and then developing as usual. There appears to be an emanation that affects the plate except where the charred ink acts as a protective coating. It is curious that films need a much longer contact than plates, and that sometimes the effect is reversed unless the film is previously washed and dried.

The Gypsies of Turkey.—Prof. W. R. Halliday has collected from a wide range of literature an account of the Turkish gypsies in the Journal of the Gypsy Lore Society (3rd series, vol. i., part 4). The conventional estimate of the number of these people in modern Turkey is 200,000, but there is no accurate material for forming any conclusion which possesses the slightest value. The more rigid Osmanli hates them as infidels and dreads them as magicians, and the Christian view of the gypsy's irreligion and genial roguery is illustrated from the folk tales. This feeling is based on the laxity of their religious observances, for in this area religious rule has the added sanction of corresponding with racial or natural cleavage. This thievish habit and way of life have naturally made them unpopular, and it is widely believed in Turkey that they dig up graves and eat corpses, a belief probably based on their habit of eating carrion. It is also stated that they drink annually a secret potion, the composition of which is known only to the oldest and wisest of the tribe, which secures immunity from snake-bite. They are also said to furnish the most expert executioners in Constantinople, but this is scarcely credible. Their employment as bear-leaders is reflected in the dislike shown towards black and brown bears, and to the use of the skins of these bears by furriers in Constantinople.

Cercariæ from Indian Fresh-water Molluscs.—Maj. R. B. Seymour Sewell has given an account (*Ind. Journ. Med. Res.*, vol. x., Suppl. Number, 1922) of the anatomy and biology of 52 cercariæ, which he has preferred to designate by numbers as he considers that at present the basis of specific distinction is vague. The majority of the fresh-water molluscs are born in May-August, live for approximately two years, and then die from natural causes. The vitality of heavily parasitised specimens is considerably impaired. The maximal periods of miracidial infection occur in May-June and in September-October, that is, just before and just after the monsoon season. During an examination of nearly 4000 fresh-water snails a double infection—two forms of trematodes developing simultaneously in the same snail—was met with only in eighteen cases, namely in sixteen *Melanoides tuberculatus* and two *Indoplanorbis exustus*, the two most widely distributed species of mollusc in India. Cases are comparatively common in which one form of trematode was found developing from parthenitæ (sporocysts or rediæ) while another was found encysted in the tissues. Maj. Sewell records that on several occasions he observed in sporocysts (producing cercariæ XV., closely related to *Cercaria vivax* Sonsino) the occurrence of miracidia—some of which were still in an incomplete state of development and enclosed in a thin capsule, but others were swimming freely in the cavity of the sporocyst. The sporocyst and redia are not sharply demarcated stages; it is easy to form a graded series beginning with an undoubted sporocyst which appears to be devoid of all structure, passing through forms—in which excretory and certain other organs are partly developed—which might be considered either as sporocysts or as rediæ, and ending with undoubted rediæ with well-developed alimentary canal, a complicated excretory system, definite nervous system and genital organs, and active locomotor processes.

Geology of New Zealand.—The latest view as to the grouping and correlation of the much-discussed strata of New Zealand is embodied in one of the pamphlets conveniently extracted from the *New Zealand Journal of Science and Technology* (vol. 5, No. 1, 1922). In this Mr. P. G. Morgan, director of the Geological Survey, gives geological maps of both the great islands, printed clearly in black and white, on a scale of 1 inch to 40 miles. If these were not so economically printed back to back, they might well be mounted by their fortunate possessor and coloured according to the international scheme. The divisions of the Maitai systems (formerly held to be Triassic and Jurassic, but now shown to be Permo-Carboniferous) are still undecided; but it is clear that the grouping of these rocks on the geographical axis of the southern island is not a tectonic feature, their general strike being north-westerly. In the epoch of their deposition, New Zealand lay on the margin of Gondwanaland, and it seems reasonable to suggest that the strike of the Maitai systems, when they came to be folded, was determined by the pressures from the south that crumpled the beds in Jurassic times in the coast-ranges of the Cape Province of S. Africa. As Mr. C. A. Cotton has pointed out ("The Outline of New Zealand," *Geographical Review*, vol. 6, p. 320), the present form and features of New Zealand have been largely determined by faulting, with the formation of blocks of uplift and depression. The dominion is developing its culture on a mere fragment of land left among the deeps.

Palæontological Research in China.—The third Asiatic Expedition of the American Museum of Natural History has been co-operating with the staff of the Geological Survey of China, and, in view of the interest taken in their joint researches, Mr. J. G. Andersson, with his colleagues of the Chinese Survey, have issued a brief summary of the results of the Survey's operations so far as carried out (Bull. Amer. Mus. Nat. Hist., xlvi. art. 13). The fossil invertebrates are being worked out by Dr. A. W. Grabau, now palæontologist to the Geological Survey of China. At present these have been obtained almost exclusively from the palæozoic deposits, and will be described in the near future in a work devoted to Chinese palæontology, initiated by Dr. V. K. Ting, the director of the Geological Survey of China, and entitled "Palæontologia Sinica." Of considerable interest is the discovery of the first Eurypterus in China in the coal measures of the Kaiping basin in strata of Lower Permian age. Coal deposits are plentiful and range from Palæozoic to early Tertiary. By far the most interesting among the plant beds of China are the Permo-Carboniferous coal series, while those of the Jurassic of northern China come next in importance, and the Oligocene flora of Fushun, in Fengtien, is the most representative of the Tertiary beds. Of the fossil vertebrates the principal description hitherto has been that of Schlosser, who, however, procured his material from Chinese medicine shops. Mr. Andersson has now brought together extensive collections. The Hipparion clays of northern China prove the richest deposits so far. The north China loess but rarely contains fossils. One of the commonest is the egg of a big ostrich, *Struthiolithus chersonensis*. There is also an elephant, doubtfully referred to *Elephas namadicus*. No undisputed proof of the existence of Palæolithic man has as yet been obtained, nor of any Older Neolithic culture.

INDUCTION MOTORS AS SYNCHRONOUS MACHINES.—In the *Journal of the Indian Institute of Science*, vol. 5, part 4, p. 37, there is an interesting and useful paper by S. V. Ganapati and R. G. Parikh on induction motors used as synchronous machines. From the point of view of the engineer of the supply station the large "wattless" current taken by induction motors is a serious drawback to their use, and methods are sometimes employed to penalise consumers in proportion to the amount of wattless current they take. The authors have experimented on induction motors by supplying their rotors with direct current and thus converting them into synchronous machines. They found that they were more unstable than ordinary synchronous motors, as a relatively small decrease in the exciting current caused them to fall out of step. They find also that, for heavy loads, this method involves a sacrifice of efficiency and only a slight diminution of the wattless current. It is also necessary to adjust the excitation to the load and hence it is unsuitable for fluctuating loads. The advantages of synchronous operation are only pronounced at times of light load.

POSITIVE AND NEGATIVE VALENCES.—The *Recueil des Travaux chimiques des Pays-Bas*, which was founded in 1882 and of which the forty-first volume has just been completed, is now to assume an international character, since it has been arranged that the *Recueil* will henceforth contain articles in French, English, and German. With this announcement there has been circulated a double number for September and October 1922, in which this policy has been put into operation. The issue contains the papers read at an International Congress of Chemistry held at Utrecht on June 21-23, 1922. It includes 14 papers, of which three are in English, four in French, and seven in German. The three Russian authors contribute two papers in French and one in German, while the Swiss contribution also appears in French. Perhaps the most interesting of these papers is the one in which Prof. W. A. Noyes discusses the question of positive and negative valences. He puts forward as evidence of the real existence of oppositely polarised atoms the production of an optically active form of the diazo compound

$$\begin{array}{ccc} +N & & CO_2C_2H_5 \\ & \diagdown\ \diagup & \\ & C & \\ & \diagup\ \diagdown & \\ -N & & CH_2.CH_2.CO_2.C_2H_5, \end{array}$$

where it is almost impossible to find a satisfactory explanation of the optical activity except by supposing that the two nitrogen atoms differ sufficiently to destroy what would otherwise be a plane of symmetry of the molecule. The question of free radicals is also discussed in two papers by Prof. Walden and Prof. Schenck.

STRESSES IN BEAMS, RINGS, AND CHAINS.—The honorary members' lecture to the Junior Institution of Engineers for the year 1922 was delivered by Prof. E. G. Coker, who chose for his subject "that branch of the elasticity and strength of materials which deals with the stress distributions in curved beams, rings, and chain links." The lecture is printed in the Journal of the Institution, Part 6, vol. xxxii., and forms a valuable résumé of the application of the optical properties of transparent bodies to the determination of the stresses in these bodies. It is pointed out that in plain stress, all materials which fulfil the primary conditions of elasticity are stressed in precisely the same manner under similar conditions of shape and loading, and so the stresses can be found by observation on transparent material like nitro-cellulose. The cases dealt with are the straight beam subjected to bending moment (to show that when the beam is unsymmetrical about the plane of bending, the usual formula giving the stress in terms of the change of the curvature is not correct), discontinuities in beams, short beams, beams of constant curvature under uniform bending moment (as being of theoretical interest), the crane hook, circular rings, elliptical link with and without stud, circular link with straight sides, and various kinds of piston rings. The mathematical treatment is indicated, while in two appendices is given in brief the mathematical theory of stresses in curved beams (Andrews and Pearson) and of stresses in curved links (Pearson-Winkler theory). Prof. Coker's lecture is a record of important researches on an important subject, to which he and his assistants have made very considerable contributions. It is of interest to note his opinion "that the stress distribution in complicated bodies . . . is one which still demands a very large amount of study by analysis and experimental research."

THE FINITISTIC THEORY OF SPACE.—The logistic mathematicians are very boastful of their claim to have solved the paradoxes of Zeno by their new definition of infinity as a compact series. Their doctrine, however, is not unchallenged. Dr. Petronievics in his "Principien der Metaphysik" has put forward the theory of the finiteness of the number of points in space. His argument is set forth from the point of view of mathematics, metaphysics, and also what he terms hyper-metaphysics, and historically it is claimed to be as old as Pythagoras. A clear, concise, and easy account of the doctrine is given in "Die Lehre vom diskreten Raum in der neueren Philosophie," by Dr. Nikola M. Poppovich (Wilhelm Braumüller, Wien und Leipzig, 1922). It is the thesis for the doctorate of philosophy awarded by the University of Berlin the year preceding the war. Dr. Poppovich reviews the whole problem of the principle of the continuity and discreteness of space from ancient to modern times. The theories fall for him into three types. The first he names the infinitistic realistic, it includes Bolzano and Cantor; the second, the infinitistic idealistic, includes Leibniz and Kant, and in the nineteenth century is represented by Renouvier; the third is the finitistic realistic doctrine of Petronievics. According to this last there is a clear distinction between real and unreal points. The essence of the doctrine would seem to be that the compact series which separates two points is not a series of real points in the sense in which the two definite points are real. The compact series has no other function than that of holding the two real points apart. Thus, to take our own illustration (if we are rightly interpreting the doctrine the integers 1, 2, in the numerical series are separated by an infinite, *i.e.* a compact, series of fractions, but this series is unreal, *i.e.* imaginary; it serves the single purpose of preventing the two units falling into one identity. The theory leads Dr. Petronievics to affirm the absoluteness of Euclidean space.

The Lourenço Marques Meeting of the South African Association.

THE twentieth annual meeting of the South African Association for the Advancement of Science was held at Lourenço Marques, in the Lyceu, on July 10-15, under the presidency of Dr. A. W. Rogers. The meeting was well attended and was very successful. About fifty papers were read. An official welcome was given by the High Commissioner for Moçambique and the Mayor of Lourenço Marques. There were various visits and excursions to places of local interest, both on the Bay and inland, and an official banquet was given to members at the new Polana Hotel.

A popular lecture, illustrated by lantern slides, was given by Mr. C. Graham Botha, Keeper of the Archives at Cape Town, on "The Early Development of South Africa."

The South Africa medal and grant were awarded to Dr. I. B. Pole Evans for his contributions to botanical science in South Africa.

The presidential address by Dr. Rogers dealt with "Post-Cretaceous Climates of South Africa." Four types of evidence on which recognition of former climates depend were discussed. These were the character of the rocks during the period concerned, the shapes of the land surface resulting from long duration of more or less constant climatic conditions, the distribution of animals and plants, and the historical records of man; the lithological evidence is the most important for all but relatively recent times. Each of these factors was considered in detail as regards South Africa, the evidence being considered from post-Cretaceous times only. Historical records of the past climate in South Africa apply closely to present-day conditions, allowance being made for the progressive settlement of the country. From personal survey work Dr. Rogers concluded that in certain districts no deterioration of climate or marked loss of water has taken place during the last fifty years. The various lines of evidence point to the conclusion that during post-Cretaceous times the climate of South Africa has fluctuated within rather narrow limits; that there has not been a Pluvial period, if by that term is implied a long period of much greater rainfall over the whole country; that a general lowering of temperature in the Pleistocene may have given the Karroo and Southern Kalahari rivers longer periods of flow, but that this more humid era in those regions had come to an end long before human evidence can be drawn upon for an account of it; and that South Africa, like North Africa, the Americas and Australia, bears evidence to a shifting of the climatic belts in the Pleistocene and subsequent times.

The presidential address to Section A on "The Rôle of Astronomy in the Development of Science," was given by Dr. M. A. Peres, Director of the Campos Rodrigues Observatory, Lourenço Marques. He summarised ably some of the chief discoveries and laws in astronomical science, and showed their influence on subsequent research in other branches of physical science. Thus, astronomical observations led to the formulation of the laws of Newton, which opened a vast field of other researches. Similar astronomical observations leading to the work on the velocity of light were the first step towards wireless telegraphy. The indebtedness of optics especially, to astronomical research, was also indicated, and it was pointed out that the chief confirmation of Einstein's theory was dependent on astronomical observations.

"The Influence of Mineral Deposits in the Development of a Young Country" was chosen by Dr. E. T. Mellor as the subject of his presidential address to Section B. This was first illustrated by reference to the Tsumeb Mine in South-West Africa and Broken Hill in Rhodesia. The Tsumeb Mine brought about the building of a railway from the coast to the mine, 350 miles away. The Broken Hill Mine practically determined the course of the main line of the Cape to Cairo railway. The railway system of the Union of South Africa has been influenced by the goldfields of the Witwatersrand. The tracing of the extension of these gold reefs eastwards, the location and exploration of new coalfields, and systematic boring for possible oilfields, all depended on an adequate geological survey. The extension of the Witbank coalfield, though proved and ready for easy exploitation, is suspended because of lack of transport and a market. The connexion of mining developments with research in other sciences was considered, and it was shown that in the gold industry South Africa possesses a field sufficiently extensive and stable to exert more than a temporary influence on the country generally.

The presidential address to Section C was given by Prof. D. Thoday, and dealt with "Carbon Assimilation" in plants. The great advances in the knowledge of the subject due to the work of Blackman in Cambridge and Willstätter in Berlin were summarised, attention being directed to the work done on pigments. The rôle of iron and of magnesium were also discussed. The application of the subject with special reference to South African conditions was detailed. The plants of the open veld are exposed to the full blaze of the sun through most of the year, and this is more than sufficient to enable an ordinary green leaf to assimilate all the carbon dioxide that it needs. Paler green or golden leaves demand more intense light than dark ones for their full activity. Consequently, veld plants have paler leaves, and in extreme cases the leaves are almost greenish yellow. Particulars of internal structure affecting depth of colour were also discussed, as were leaf forms and patternings, and it was emphasised that such features are not merely adaptations to a dry climate but that their effects on photosynthesis of carbon dioxide are probably of equal significance.

The presidential address to Section D was delivered by Dr. Annie Porter, her subject being "Some Modern Developments in Animal Parasitology." After a general introduction dealing with degrees of parasitism, specificity and the like, recent advances in protozoology were first considered. Attention was directed to the conflicting opinions as to the existence of races of *Entamœba histolytica*. The work of Taute and Huber on the non-identity of *Trypanosoma rhodesiense* and *T. brucei*, as shown by direct inoculation of the human subject with game trypanosomes, was discussed, and attention was directed to work on induced herpetomoniasis in vertebrates. Flagelloses of plants were described, especially those due to herpetomonads, some of which had been proved capable of infecting mammals; also the spirochætes, amœbæ, and other parasitic Protozoa found in plants and their reactions on their hosts were noted. Recent work on neuromotor apparatus in Protozoa, and on various organisms and filterable viruses associated with infective (spirochætal) jaundice, trench fever, and typhus were discussed. In helminthology the interesting life-histories of schistosomes in various snails, of Clonorchis in snail, fish and man, of Paragonimus in snail, crab or crayfish and man, and recent work on the life-histories of such organisms as *Fasciolopsis buski*, Heterophyes, Ascaris, and Strongyloides were detailed. In entomology hyperparasitism and its possible applications, Stomoxys as the transmitter of North African trypanosomiasis, the rôle of *Trombidium akamushi* in river fever in Japan, and the part played by various ticks in a peculiar form of human motor paralysis in America were among the topics discussed. In conclusion, some of the sociological applications of parasitology were mentioned, and the need of more provision for research work was emphasised.

The presidential address to Section E, by Senator A. W. Roberts, related to "Certain Aspects of the Native Question." The changes in national life and in the mental attitude of the native, due to gradual disappearance of the old tribal system, were discussed. The growing desire for individual possessions and the movement among the younger generation of Bantus for racial solidarity were considered as natural steps in the evolution of a race. The immigration of the native into industrial areas, the change in habit and in outlook, the bad features of location life, and the need for proper housing were emphasised. The history of native education was traced, and it was shown that the system in vogue at present had served its purpose. New ideals in native education should be in the direction of material progress, better means of agriculture, and village and home industries. The principles of good citizenship need impressing on the native as well as on the white. The extension of opportunities of work for educated natives and their feeling regarding their present economic limitations were discussed. The political future of the native and the extension to other areas of the system successful in the Transkei were considered. Mutual understanding between white and native is necessary.

The presidential address of Dr. J. Marius Moll to Section F was entitled "Certain Mental Disorders which may be regarded as Preventable." Mental disorders were considered in two groups—the "intoxication" psychoses caused by a poison in the wide sense and producing changes in the brain, and "germ" or "functional" psychoses where no causative poison occurs, no microscopic alterations, and no dementia. The intoxication psychoses due to other illnesses, *e.g.* enteric, were briefly noted. Alcoholic insanity, with its great danger of recurrences, was considered. In the case of inmates of native mental hospitals in South Africa, dagga (*Cannabis indica*) may be an important etiological factor. Syphilis is decreasing in South Africa. Malaria is not only a factor in some cases of insanity but also in intellectual retardation and enfeeblement in the country. Dementia precox is serious, 21 per cent. of the admissions to mental hospitals in the Union being due to this. The work on internal secretions and on psychopathology was mentioned. In the germ psychoses the personality of the patient is the main factor. The rôle of sex-complexes was shown to have been overrated by Freud and some of his followers. The reciprocal reaction between the personality and the circumstances of a patient had to be reckoned with. The need for study and adoption of the principles of mental hygiene was urged. Heredity was a serious factor in insanity. If segregation and non-propagation of the mentally unfit were enforced the future incidence of this condition would decrease by 50 per cent.

It is only possible to notice some of the interesting papers read before the various sections. Nearly half of the papers were contributed to Section D.

In Section A a useful paper was read by Mr. R. H. Fox on the waterworks department of the Antofagasta (Chile) and Bolivia Railway Company.

In Section B, Mr. B. J. Smit contributed a paper on his investigations of different methods of testing Babcock milk-bottles; the volumetric method was preferred. Mr. C. O. Williams continued his account of experiments on the chemical control of cattle-dipping tanks; the addition of coal-tar disinfectants to arsenical dips was uneconomical. Dr. P. A. Wagner described various specimens of Descloizite from South-West Africa.

In Section C, Prof. G. Potts continued his account of experiments on the pollen of the pepper tree as a cause of hay fever in Bloemfontein. Prof. J. W. Bews and Mr. R. D. Aitken discussed the measurement of the hydrogen ion concentration in South African soils in relation to plant distribution. Mr. Aitken also described the effect of slope exposure on the climate and vegetation of a hill near Maritzburg. Mr. A. J. Taylor dealt with the composition of some indigenous grasses both from the chemical and the botanical aspects. The economic values of the grasses were indicated.

In Section D, Mr. J. Sandground read a short paper on *Aphelenchus phyllophagus*, parasitic in chrysanthemums, noting its effects in South Africa. Prof. E. H. Cluver dealt with the effect of temperature on the rate of growth in young animals; the greatest increase in weight occurred during the cooler months. Mr. A. D. Stammers described keratomalacia among rats suffering from deficiency of vitamin A. Dr. C. P. Neser sent an interesting paper on the blood of equines. Prof. E. Warren described and illustrated the early stages of development of the non-aquatic tadpole of *Anhydrophryne rattrayi*; predetermination of sex occurred in the eggs. Prof. J. E. Duerden discussed old and new views on the origin of feathers from scales. Prof. Duerden and Mr. R. Essex described the degeneration of limbs in species of Chamæsauran lizards. Prof. Duerden and Mr. V. FitzSimons recorded a series of variations found by them in the tenth rib of the penguin. Dr. F. G. Cawston described and exhibited specimens of Mollusca from lagoons in Natal. Prof. H. B. Fantham continued his account of some parasitic Protozoa found in South Africa, noting the occurrence of herpetomonads in cabbage plants. Prof. Fantham and Miss E. Taylor described the continuation of their researches on Protozoa found in some South African soils. Mr. C. B. Hardenberg discussed economic entomology in Moçambique. Dr. L. Soromenho described, from the hygienic point of view, various native wines and spirits made in Moçambique. Dr. M. M. Prates presented a contribution to the study of human parasitology in Moçambique, and he also described the various diseases of the eyes occurring there. Mr. J. Hewitt discussed ancient southern land connexions of Africa. The section considered favourably a draft bill for the establishment of a national park and game reserve under the direct control of the Union Government.

In Section E, Rev. C. Pettman contributed further remarks on Hottentot place-names. Rev. H. L. Bishop read interesting papers on Si Ronga proverbs and folklore and on the descriptive complement in Si Ronga. Madame V. Gomes discussed the N and L intervocalic in archaic Portuguese. Prof. W. A. Norton dealt with Dr. Theal's historical work on South-East Africa, and pleaded for a continuance of such work. He also exhibited a glossographic map of South Africa.

In Section F, Mr. C. G. Botha illustrated the early history of the Cape Province by a consideration of

Dutch place-names. Mrs. Mabel Palmer discussed some Australian proposals for a wage varying in proportion to the size of the family. Mr. F. S. Livie-Noble outlined some practical applications of modern psychology. There was a discussion, opened by Captain A. Cardozo, on the currency problem in Moçambique.

The next annual meeting of the Association will take place in July 1923 at Bloemfontein, under the presidency of Prof. J. D. F. Gilchrist. H. B. F.

Mental Character and Race.

IT is a commonplace of anthropological study that, in investigating the customs of primitive races, the difference in level of culture between observer and observed entails a difference in mentality and outlook which it is one of the aims of anthropological training to overcome. But it is also a matter of common observation that this same difference exists, if in a lesser degree, between peoples at the same stage of civilisation, and even between individuals or groups of individuals forming part of the same people or nation. The works of travellers, geographers and historians, both ancient and modern, abound in characterisations of the mental qualities of the various peoples of the world, both civilised and uncivilised; but when the ethnologist comes to the investigation of the problem of racial differences in mental qualities, he is confronted with a two-fold difficulty. On one hand he is, at present, for the most part, dependent upon empirical observation from which it is difficult to eliminate the personal factor, and, on the other hand, it is not clear how far, if at all, mental characters can be correlated with the physical characters upon which the ethnologist bases his classification of races. In the solution of this problem it is essential that the anthropologist should secure the co-operation of the psychologist, and it was with this object that a discussion on "Mental Character and Race" was held in a joint session of the Anthropological and Psychological Sections at the meeting of the British Association at Hull in September last.

The discussion was opened by Prof. J. L. Myres, who said that the principal consideration to be submitted to psychologists and ethnologists alike was that in many individuals in any modern society of mixed ancestry, dispositions and faculties differ. Such mental qualities are inherited like physical qualities and characters. It might be assumed that they stood in some direct relation to some element in the nervous system. Further, some mental qualities seemed to be associated with some physical characters, as for example a "fiery" temperament with red hair. Some of these physical characters are racial, or (like red hair) seem to result from crossing of racial elements. The analogy from the artificial selection of the breeds of domesticated animals indicates that it is possible to enhance or combine mental qualities. It did not always happen that the individual exhibited the characteristics desired, as in the case of the "gun-shy" pointer, and the "gun-shy" member of a military family. It would appear, however, that the hypothesis of correlation and transmissibility of psychical characters stands the test of practice in domesticated animals, the nearest analogue to the long domesticated animal man, a single species broken up into strongly marked racial strains.

Prof. Myres went on to point out that the older ethnologists characterised racial types by mental as well as physical characters, and quoted as an example the character of the Northern Mongols in Keane's "Man, Past and Present." He pointed out that such a characterisation included: (*a*) a description of mere psychological reactions to external stimuli conceived as characteristic of the racial strain and capable, like brachycephaly, of being used to refer an individual to his racial type; (*b*) a description of social reactions (*e.g.* "sense of right and wrong") in which a social, cultural element was introduced. The individual has a post-natal experience as well as a pre-natal equipment, and in investigation it might be difficult to eliminate disturbing factors. Prof. Myres stated, however, that he himself had found that the offspring of British fathers and Greek mothers brought up in a Greek environment differed as markedly from pure Greeks in their attitude towards discipline and labour as they did in physique, temperament closely following breed.

Modern ethnology, relying on analogue and experiment, had made most progress in the department of sense perception; but even here one of the first results had been to show how intimately the social factor was involved, as for example in inducing a native to give a fair trial to an experiment beyond his social horizon and in eliminating the disturbing factor of an inadequate language, *e.g.* in the case of colours.

In summing up the problem, Prof. Myres said that the ethnologist, and, in particular, the social anthropologist, must define more clearly the elementary terms in their characterisation, while the psychologist must go further in laboratory work on such complex manifestations as the "sense of right or wrong," irrespective of race or breed.

Dr. C. S. Myers, president of the Psychological Section, said that the chief determinants controlling mental characters were heredity and environment. On the physical side environment—climate, temperature, food supply, and the like—acted directly and indirectly, especially on the internal secretions which affect the functions of the emotions. Environment must have played an important part in producing such differences as distinguished Americans, Australians, and New Zealanders; but it was not known with certainty how these differences came about, nor how permanent they were likely to be. Different parts of the same country exhibited distinguishing characteristics. In England, for example, Yorkshire and Wales had for long been noted for musical ability. What did this mean in terms of race? Where there was lack of ingenuity or artistic skill, were these qualities latent, awaiting the encouragement of a more favourable environment? Rivers had shown that contact of culture produced something new, and apparently the same applied to an individual.

Dr. Haddon said the results of the psychological observations made by the Cambridge Expedition to the Torres Straits had been largely negative. A scheme should be worked out for the observation of the emotional content of the attitude of primitive peoples towards their own ceremonies.

Dr. Cyril Burt said that experimental tests of intelligence and other inborn mental capacities usually yield a correlation of about 0·5 between the performances of parents and those of their children. Thus, mental qualities seem to be inherited to much the same degree as physical. Small but distinct and constant differences are discernible between the averages for different nations and races. On the whole, however, individual differences tend almost to swamp the group differences. On the temperamental side, group differences are possibly larger; and there is some evidence to show that differences of so-called temperamental type may be associated with racial differences (*e.g.* the so-called "objective" type with Nordic physical features and the so-called "subjective" type with Mediterranean).

Mr. Fallaize pointed to the persistence of certain mental qualities in different races noted by the older travellers and historians.

Dr. Shrubsall said that he had observed that the children of Chinese fathers and English mothers in London schools, brought up in much the same environment as English children, were intellectually as quick as the latter but showed no inclination to take part in games. Among English children differences in pigmentation appeared to be associated with differences in direction of aptitude.

In summing up the discussion, Mr. H. J. E. Peake, the president of the Anthropological Section, said that while no very definite conclusion had been reached, it was clear that the aim of investigators must be to eliminate the personal element, while psychologists should endeavour to break up mental characters into such simple factors as might be subjected to reaction tests, as courage had been shown to be the reaction to danger.

Scientific and Industrial Research.[1]

THE Committee of the Privy Council for Scientific and Industrial Research has issued its seventh annual report, with that of its Advisory Council, covering the year 1921–1922. The first few pages deal with the income and expenditure of the Department of Scientific and Industrial Research, and with its efforts to observe the spirit of national economy. It is pleasing to record that the Geddes Committee on National Expenditure has not found it necessary or expedient to recommend any reduction in the estimates beyond that proposed by the Department itself. The total expenditure during the financial year 1921–1922 was nearly 525,585*l*., made up of 190,024*l*. at the National Physical Laboratory (nearly 100,000*l*. being recovered in fees, etc.), 46,616*l*. at the Fuel Research Station, 57,423*l*. for the Geological Survey and Museum, 10,323*l*. at the Building Research Station, 17,750*l*. at the Low Temperature Research Station, 21,464*l*. on the work of the Co-ordinating Boards and Committees, 5988*l*. on minor research programmes, 86,355*l*. (from the million fund) in grants to the Research Associations, 8287*l*. in grants to other bodies, 43,793*l*. in research studentships, and 37,561*l*. on administration at headquarters.

By far the major portion of the report, however, deals with the plans and achievements of the various research organisations associated with the department. Considerable interest will be awakened in the twenty-four industrial research associations, twenty-two of which are already in active operation. A few of these associations have now been in existence long enough to have produced results of practical value, examples of which are given. Thus, the British Portland Cement Research Association has been able to effect considerable economies in fuel in many works through the results of its researches on rotary kilns and advice on scientific management. The British Scientific Instrument Research Association has introduced a new polishing powder and an abrasive for the production of lenses and prisms, by means of which grading and hand work are eliminated, and much time is saved. The British Cotton Industry Research Association has produced an instrument for the testing of yarns, continuous lengths being examined instead of short pieces as hitherto, with the result that important variations have been revealed in certain yarns, which are introduced by the method of spinning. Finally, the Linen Industry Research Association has developed a pedigree strain of flax seed which gives much higher yields of fibre than any existing variety, and has discovered methods whereby flax and hemp may be distinguished at all stages of manufacture. It is obvious that these are not isolated pieces of work, but rather the first-fruits of a considerable harvest which has been patiently husbanded by the research associations, and it is no secret that a mere catalogue of the further results which have been published in the scientific press since the report was written would occupy considerable space.

The value of co-operation between the research associations is emphasised again. Several instances are mentioned of two or more associations attacking a common problem, the most interesting cases being those in which the participants are respectively consumers and producers of the materials investigated. Mutual efforts of this kind must result in improvements in useful commodities and possibly in a lowering of the cost of production.

Considerable space in the report is also devoted to the work of the co-ordinating research boards, which more directly serve national interests. Attention is directed to the commendable willingness of the Service departments to enlist the co-operation of outside bodies and to arrange for the open publication of the results of the work undertaken when these are of sufficient general interest. The co-ordinating research boards consider an enormous variety of problems in physics, chemistry, and engineering, including radio-telegraphy, the liquefaction and storage of gases, the deterioration of fabrics used by the fighting services, adhesives, and lubrication, and the report mentions several of the results obtained. Furthermore, public interest should be aroused in the work of the Fuel Research Board, which has issued most valuable information in a number of publications which have already been noted in these columns; *e.g.* in NATURE of November 25, 1922, p. 718, when the report on experiments on low temperature carbonisation was discussed. The work of the Food Investigation Board is also of common interest, and important advances are reported in the study of cold storage, and the bacteriology of canned meat and fish.

A useful discussion of the terms "pure" and "industrial" research is given, the distinction being mainly a question of the source from which the impulse to the conduct of research is derived. It has been all too common on the part of workers engaged in "pure" research for a very few problems to be pursued through all inviting ramifications, with the result that while certain small areas may be very thoroughly cultivated, the worker remains unimpressed by the vastness of the unexplored territory outside his own subject. The problems facing any one industry are much more varied than is frequently imagined, and the gaps in scientific knowledge which they reveal are often astonishing. For example, the Cotton Research Association finds it necessary

[1] Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1921–22. (Cmd. 1735.) Pp. iv+123. (London: H.M. Stationery Office, 1922.) 3s. net.

to study the fundamental properties of single cotton hairs, the existing data being very scanty; the Photographic Research Association is investigating the properties of silver haloids and gelatin; the Portland Cement Research Association is endeavouring to ascertain the exact nature of the compounds constituting Portland cement; and the perfection of an abrasive and a polishing powder by the Scientific Instrument Research Association followed an investigation of the primary phenomena of grinding and polishing.

Two interesting examples of the interplay of "pure" and "industrial" research are given. On one hand, the knowledge gained by an investigation into the fundamental physiology of living and dead food-stuffs has cleared up the mystery of the "brown-heart" of apples, which has caused severe losses in shipments from Australia. The "disease" has been attributed to insect injury in the orchards, but is now known to be due to the effect of the carbon dioxide engendered by the fruit itself in the badly ventilated holds of the ships. On the other hand, the study of the structure of coke at the Fuel Research Station has led to the conclusion that carbon in this form is a vitreous substance of great hardness, which profoundly affects the problem of the allotropy of this element. Some of the results obtained were described in NATURE of January 27, p. 133.

The industrial research associations are comparatively young bodies, but such as have already issued reports on investigations undertaken have given ample justification for their existence.

The Gold Coast Survey.

THE Survey Department of the Gold Coast, which was closed during the war, was reopened in 1920 by the present Governor, Sir F. G. Guggisberg, who had formerly initiated the survey of a considerable portion of Nigeria. The long cessation of survey work on the Gold Coast had left matters in a backward state. To cope with immediate needs the department was strengthened, and it is believed that by 1924 the lost ground will have been regained and the country will be provided with a modern survey department. Lieut.-Col. R. H. Rowe is in charge of the new department, with Maj. G. H. Bell at the head of the field-work. The survey parties are organised in three sections which refit in England from July to September, when they leave for the Gold Coast in order to take full advantage of the "dry" season. Each section is divided into several completely equipped "field camps," under European surveyors.

The country that has been surveyed during the last two field seasons has been mainly dense tropical forest, presenting great difficulties to the surveyor. Lines must often be cut through the forest in order to reveal the surface features. Even in the dry season there are climatic difficulties. From December to March the harmattan frequently occurs and obscures the vision. At other times the dry winds warp and split the woodwork of boxes, instruments, and tent-poles. The surveyors, of course, have to face malaria and other forms of sickness.

FIG. 1.—A field survey camp on the march.

An important part of the new Survey Department is the Survey School at Odumase for the training of native surveyors. A three years' course in the school, followed by four years' service with the Government, qualifies a native to start in private practice. There are apparently good openings in this profession for African surveyors.

In addition to the Topographical branch of the survey there are two others—the Cadastral and the Records and Reproduction branches. In the Cadastral branch a great deal of work on land surveys and town plans has been done. The Records branch is gathering material for gazetteers and handbooks of the country, and the Reproduction section is engaged in printing road-maps, statistical maps, and diagrams. The topographical sheets of the survey on a scale of 1 to 125,000 are not being printed in the colony, but by Messrs. W. and A. K. Johnston (see NATURE, November 11, p. 647), to whose courtesy we owe the accompanying illustration (Fig. 1). About 15,000 square miles have already been surveyed, and it is expected that the present season's field-work will practically complete the maps of the Gold Coast Colony itself and also a large area in Ashanti.

Paris Academy of Sciences.

Bonaparte and Loutreuil Funds.

Grants for research from the Bonaparte and Loutreuil funds have been allocated as follows:

Bonaparte Fund.—Six applications have been examined and two grants are recommended:

(1) 5000 francs to the Association lyonnaise pour le développement des recherches de paléontologie humaine et de préhistoire, for carrying on excavations in the celebrated prehistoric deposits of Solutré.

(2) 2000 francs to Charles Le Morvan for completion of the publication of the systematic and photographic map of the moon.

Loutreuil Fund.—Thirty-one applications were considered and grants were recommended as follows:

(1) The National Museum of Natural History: 8000 francs to Désiré Bois for the publication of the first two parts of a guide to the collections of cultivated plants at the museum.

(2) The central council of observatories: 1000 francs to the National Observatory of Besançon for the acquisition of an Abraham oscillograph; 3000 francs to Auguste Lebeuf, for the purchase of an oven required for researches relating to the simultaneous action of temperature and pressure on chronometers, for aviation purposes.

(3) Council for the improvement of the École polytechnique: 6000 francs to Alfred Perot, for the construction of an apparatus designed for the verification of a formula given by the Russian physicist, W. Michelson.

(4) National Veterinary School of Alfort: 1000 francs to the school, which, together with balance of 8000 francs remaining from the sum granted in 1920, is allotted as follows:—5000 francs to Adrien Panisset and Jean Verge, for researches on the chemicotherapy of the infectious diseases of domestic animals; 2000 francs to Edouard Bourdelle and André Rochon-Duvignaud, for researches on vision in animals; 2000 francs to Albert Henry and Charles Leblois, for researches on the etiology, pathogeny, and treatment of parasitic cutaneous affections of domestic animals; 600 francs to Gabriel Petit, for the purchase of a microscope.

(5) National Veterinary School of Lyons: 4000 francs to François Maignon, for the continuation of his researches on organozymotherapy and for a study of the physico-chemical constitution of the diastases and the mechanism of their action; 4000 francs to Joseph Basset, for the purchase and feeding of experimental animals required for testing two new methods of producing immunity; 2000 francs to G. Marotel, to allow him to continue his researches on the treatment of mange in the dog by a new method.

(6) National Veterinary School of Toulouse: 2500 francs to Charles Besnoit for an experimental study of the methods of intensive application applicable in bovine surgery, and for printing a phototype catalogue for general use; 2000 francs to Jean Lafon, for completing the previous grant of 3000 francs for the purchase of an Einthoven string galvanometer; 1000 francs to Charles Hervieux to enable him to pursue his researches on the transformation in the animal organism of pyrrol groups contained in food, and the elimination of these groups by the urine; 1000 francs to Charles Besnoit and Victor Robin, for a study of the contagious diseases of poultry in the S.W. region.

Independent Grants.—1000 francs to Julien Achard, for completing his monograph on the Madagascan coleoptera of the family of Scaphideideæ; 6000 francs to the Association amicale des élèves de l'École nationale supérieure des Mines for a study of the methods and apparatus for the control of combustion, especially as regards the estimation of carbon dioxide in flue gases; 5000 francs to the École supérieure de perfectionnement industriel as a contribution to the expenses of this institution; 2000 francs to Wilfred Kilian to assist the publication of a geological bibliography of the south-east of France; 5000 francs to Emmanuel de Margerie, for the preparation of the publication of a tectonic map of Eurasia; 15,000 francs to Jean Mascart, for the publication of a part of the astronomical work of Luizet; 3000 francs to M. Mugnier-Serand for his researches on atmospherics in wireless telegraphy and their application to the prediction of storms; 15,000 francs to the Academy of Sciences for the publication of the catalogue of scientific periodicals in Paris libraries.

University and Educational Intelligence.

Birmingham.—The twenty-third yearly meeting of the Court of Governors is to be held on February 8, and a summary of the events of the past academic year will be presented in the reports of the council and principal (Mr. C. Grant Robertson). The number of students during the past session showed a slight falling off, and the proportion of women increased, except in the Faculty of Medicine, in which it was lower than it had been for some years. It is hoped to repeat, during the present session, the post-graduate course on "The Medical Aspect of Crime and Punishment," for qualified practitioners, which was given last year by Drs. Maurice Nicolls (lecturer in psychotherapy), Hamblin Smith, W. A. Potts, and Percy T. Hughes. Sir Frederick Mott has been appointed, for three years, lecturer in morbid psychology. A Board of Research in Mental Diseases, on which the University and the Asylums Committee of the City Council are represented, has been formed. Sir Frederick Mott is honorary director of research, and the funds are being supplied by the Asylums Committee of the City Council. The most urgent need of the University at present is the removal of the biological group of sciences to new buildings at Edgbaston. This would set free room at Mason College which is urgently required for the Faculties of Arts and Medicine. Reference is made to the successful work of the Workers' Educational Association, and the importance of the co-operation of the University in that work:—"It is essential that the educational work should be controlled by the Universities, if only to secure the right standard . . ., and the need of additional qualified University instructors . . . is already apparent."

Mr. A. W. Nash has been appointed senior lecturer in petroleum technology under Prof. R. R. Thompson. Mr. Nash has had experience in petroleum production and refining in Persia, Russia, and other parts of the world.

Cambridge.—Sir Alfred Yarrow has offered money for a three-year studentship in Assyriology to provide for the training of a suitable student in a subject which has for the time vanished from the University. He and Lady Yarrow further offer, "if the student prove himself a competent scholar and is prepared to continue the study of Assyriology," to establish with a stipend of 500*l*. a year an "Eric Yarrow lectureship for the study of Assyriology" in memory of Sir Alfred's son, who fell in the war.

A new University lectureship in Psychopathology is advertised as vacant.

Prof. Zschokke, head of the faculty of zoology in the University of Basle, will lecture this term on the European fauna.

The governing body of Emmanuel College offers to a research student commencing residence at the

College in October 1923, a studentship of the annual value of 150*l*., which shall be tenable for two years and renewable, but only in exceptional circumstances, for a third year. The studentship will be awarded at the beginning of October, and applications should be sent so as to reach the Master of Emmanuel, The Master's Lodge, Emmanuel College, not later than September 18.

LONDON.—The Senate has resolved to increase the annual grant to the Marine Biological Association, Plymouth, from 25*l*. to 50*l*. for the next five years.

The following doctorates have been conferred :—*D.Sc. in Embryology* : Mr. G. S. Sansom, an internal student, of University College, for a thesis entitled "Early Development and Placentation in *Arvicola* (*Microtus*) *amphibius*, with special reference to the Origin of Placental Giant Cells." *D.Sc. in Physiology* : Dr. G. V. Anrep, an internal student, of University College, for a thesis entitled "The Metabolism of the Submaxillary Gland."

Dr. Eustace E. Turner has been appointed demonstrator in the chemical department of the East London College.

ST. ANDREWS.—Principal J. C. Irvine, Dr. William Low, and Dr. Angus MacGillivray have been appointed representatives of the court of the University on a standing joint-committee constituted by the court and the directors of the Dundee Royal Infirmary for the purpose of recommending suitable candidates on the occurrence of vacancies in the chairs of clinical medicine in the University, and also of harmonising the activities of the University and the Infirmary in matters common to both. Prof. D'Arcy Thompson has been reappointed representative of the court on the council of the Scottish Marine Biological Association.

MAJOR-GEN. SIR GERALD ELLISON will unveil the war memorial of East London College on Wednesday, February 7, at 3 P.M.

A SWEDISH professor of education, contrasting Swedish and American schools, remarked that in his own country the word "teacher" is not a noun feminine as it is in America. That the criticism is not without some foundation is shown by the statistics published in Bulletin, 1922, No. 8, of the United States Bureau of Education. The number of men students enrolled in normal courses in all normal schools and teachers' colleges in 1919–20 was 19,110 out of a total of 135,418, or 14 per cent ; in teachers' colleges the percentage was 18, in state normal schools 13, in city and county normal schools 6, and in private normal schools 9. Comparative tables of statistics of the five years 1899–1900, 1904–5, 1909–10, 1914–15, and 1919–20 give the numbers of women students in normal courses as 45,394, 49,346, 68,815, 80,347, 116,308, representing the following percentages of the total numbers of students in such courses : 65, 76, 78, 80, 86. The teachers' colleges referred to, 46 in number, are institutions having a four-year course above the secondary school and granting a degree. Of the total number of men students in normal courses (19,110), more than half (9763) were enrolled in these colleges. It is true that a very large proportion of the teachers in American schools have not passed through normal schools and that the percentage of men teachers is not necessarily the same as the percentage of men students in teacher-training institutions. Statistics of City School Systems 1919–20 (Bulletin, 1922, No. 17), however, tell a similar tale. They show that the percentage of men teachers in city schools (including schools in towns having a population of 2500 or more) is 11, while in city elementary schools the percentage is only 4. It is probably safe to assume that rural schools would show an even lower percentage.

Societies and Academies.

LONDON.

Royal Society, January 25.—Sir Charles Sherrington, president, in the chair.—**A. V. Hill** : The potential difference occurring in a Donnan equilibrium and the theory of colloidal behaviour. Loeb has shown experimentally that there is a potential difference between a colloidal solution of a protein and a crystalloid solution with which it is in equilibrium across a membrane, impermeable to the protein, but permeable to the other bodies involved. It varies in the same general manner as the osmotic pressure, the viscosity and the swelling. The variation can be deduced, in general, from the theory of the Donnan equilibrium. One of the chief arguments employed by Loeb, however, is incorrect. Loeb shows that the potential difference observed experimentally agrees very exactly with that "calculated" from the difference in hydrogen ion concentration, also observed experimentally. This is a necessary consequence of the manner in which the observations were made.—**E. F. Armstrong** and **T. P. Hilditch** : A study of catalytic actions at solid surfaces. X.: The interaction of carbon monoxide and hydrogen as conditioned by nickel at relatively low temperatures. A practical synthesis of methane. A mixture of equal volumes of carbon monoxide and hydrogen passed over nickel at temperatures 220–280° C. was largely transformed into methane and carbon dioxide :

$$2CO + 2H_2 = CO_2 + CH_4.$$

This action affords the simplest and most economical means of producing methane in quantity, since a suitable gas mixture exists in ordinary commercial water-gas when the latter has been freed from catalyst poisons by removal of sulphur compounds. The experimental data obtained are compatible with a combination of the "water-gas reaction" with the normal hydrogenation process. Thus, of two volumes of water-gas ($2CO + 2H_2$), one molecule of carbon monoxide and a molecule of water interact and yield a molecule each of carbon dioxide and of hydrogen, the latter, with the balance of hydrogen present in the original gas, furnishing sufficient hydrogen for the normal hydrogenation of a second molecule of carbon monoxide.—**J. Holker** : The periodic opacity of certain colloids in progressively increasing concentrations of electrolytes. The method of testing the effect of common salt on the typical emulsoid colloid, serum, was described. Into each test-tube was pipetted 0·5 c.c. of undiluted serum and to each was then added 2 c.c. of solution of sodium chloride, which progressively increased in concentration in each successive tube. The tubes were shaken and placed in a thermostat at 40° C. for four hours. Then the opacity of the solution was determined. The phenomenon is periodic and is given by colloids of both the emulsoid and suspensoid type, and by animal, vegetable, and mineral colloids. It is also given by certain mixtures of simple aqueous solutions of inorganic salts. Emulsoid colloids tend to give many oscillations of low amplitude. Suspensoid colloids tend to give few oscillations of high amplitude. The phenomenon is not an optical interference of the light scattered by colloidal particles, but is a definite oscillatory change in the physical condition of those particles.—**E. K. Rideal** and **R. G. W. Norrish** : The photochemistry of potassium permanganate. Pt. I : The application of the potentiometer to the study of photochemical change. Pt. II. : On the energetics of the photodecomposition of potassium permanganate. The electrode potential of potassium permanganate when illuminated with ultra-violet light from the mercury vapour lamp undergoes a change (*ca* 0·25 volt) and recovers slowly in the dark. This change is correlated with a photochemical decomposition of the permanganate, made apparent by the separation of a precipitate of the composition $K_2O.2MnO_2$, and the formation of a sol of MnO_2. Illumination establishes a photochemical stationary state, KOH being simultaneously produced by the decomposition, and removed by combination with the colloidal MnO_2. This involves an alteration of the P_H of the solution, which causes the electrode potential changes. The decomposition is monomolecular over the range of concentrations investigated. The decomposition of acidified permanganate under identical conditions is of zero order, due to non-formation of colloid. The photoactive radiation lies in the ultra-violet absorption spectrum of potassium permanganate, and the Hg line at 3128 AU is considered the chief agent. The quantitative absorption of radiant energy is in agreement with the Einstein Law of Photochemical Equivalent, a result of special interest as the first instance of its application to solutions.—E. A. **Fisher**: Some moisture relations of colloids. Pt. I.: A comparative study of the rates of evaporation of water from wool, sand and clay. Curves obtained by plotting rates of evaporation against water contents are discontinuous. Each portion of the rate curve can be expressed by a simple type of equation connecting rate of evaporation with water content. The rate curves obtained are similar in type in the cases of wool (wholly colloidal with a cellular structure), quartz sand (wholly non-colloidal with a granular structure), silty soil (notoriously feeble in colloid properties), and heavy clay sub-soil (typically colloidal in behaviour). The so-called shrinkage of wool on drying is really a deformation and not a volume shrinkage. The absorption of water by wool is attributed primarily to a filling up of fine pores of various shapes and sizes; the vapour pressures of wool-water systems are determined by the diameters of the pores that are full of water.—R. **Whytlaw-Gray**, J. B. **Speakman** and J. H. P. **Campbell**: Smokes. Pt. I.: A study of their behaviour and a method of determining the number of particles they contain. The smokes were produced (*a*) by the arc discharge in air, (*b*) by volatilisation and condensation, (*c*) by chemical action. In each case highly dispersed systems of very minute particles were obtained. Examined in an ultra-microscope of the slit type, the life-history of a smoke falls into two main periods:—(*a*) An unstable period in which the number of particles diminishes rapidly with time. (*b*) A stable period in which the decrease in number is slow. During the first period the increase in size is very marked; the changes are not due to evaporation but to a process of aggregation, which produces complexes of different structure depending on the nature of the dispersed substance.—R. **Whytlaw-Gray** and J. B. **Speakman**: Smokes. Pt. II.: A method of determining the size of the particles they contain. A filtration method is used which enables the concentration in weight of the suspended solid matter in rapidly changing smokes to be determined with an accuracy of about 3 per cent. A given volume of smoke (usually 1 litre) is filtered through small tubes containing asbestos, and the increase in weight is ascertained by a micro-balance sensitive to 0·0002 mgm. Filtration takes about five minutes. Curves have been obtained showing the variation in weight concentration of the smoke over periods of 0-6 hours. Knowing the weight and the number of the particles in a given volume, the average mass of a smoke particle at different periods can be calculated and the growth followed quantitatively. Assuming the density of the particle to be that of the substance in bulk the average radius can be evaluated. All the weight-concentration curves show an initial rise, and this fact, in conjunction with ultra-microscopic observations, renders it probable that all these clouds contain in the early stages a large number of invisible particles of a microscopic size.—R. C. **Ray**: The effect of long grinding on quartz (silver sand). When quartz (silver sand) is ground for a long time the density of the ground substance is lower than the one which has not been subjected to grinding. The fall of density shows that as much as 25·7 per cent. of the material is converted from the crystalline to the vitreous condition. This value agrees fairly with that derived from the molecular heats of solution.

Geological Society, January 10.—Prof. E. J. Garwood, vice-president, and afterwards, Prof. A. C. Seward, president, in the chair.—W. J. **Sollas**: Man and the ice-age. Four ancient coast-lines of remarkably constant height have been traced around the Mediterranean Sea and along the western shores of the North Atlantic Ocean. These, with their associated sedimentary deposits, form the successive stages of the Quaternary system; namely, the Sicilian (coast-line about 100 metres); the Milazzian (coast-line about 60 m.); the Tyrrhenian (coast-line about 30 m.); and the Monastirian (coast-line about 20 m.) The Sicilian deposits contain a characteristic cold fauna. The fauna of the Milazzian is warm-temperate and of the Tyrrhenian and Monastirian still warmer. The three lower coast-lines correspond with the three lower river-terraces of the Isser (Algeria), the Rhône, and the Somme. Hence it may be inferred that the position of the river-terraces has been determined by the height of the sea-level. The climate of the Quaternary age was, on the whole, warm-temperate or genial, but interrupted by comparatively short glacial intervals. It is now possible to assign the palæolithic stages of human industry to their place in the Quaternary system: thus the "Strepyan" or pre-Chellean is Milazzian in age, the typical Chellean, Tyrrhenian, the evolved Chellean, Acheulean and Lower Mousterian, early Monastirian, and the Upper Mousterian, Aurignacian, Solutrian, and Magdalenian, later Monastirian. The coast-lines of the Northern Hemisphere appear to have their counterparts in the Southern Hemisphere. The Quaternary movements are probably due to a general deformation of the globe involving eustatic changes in the level of the sea.

Optical Society, January 11.—C. **Davidson**: On the amount of the displacement in gelatine films shown by precise measurements of stellar photographs. A stellar photograph consists of a number of minute discs scattered over an otherwise transparent plate. The purpose of the photograph is to determine with precision the relative positions of these discs. In the trigonometrical method of determining stellar parallaxes photographs of a selected region are taken at two epochs about six months apart when the earth is at opposite sides of its orbit. A new star will show a displacement relatively to the distant stellar background. A series of such photographs give equations from which the parallax and proper motion are determined. After the computed quantities have been taken out, each plate will show a small residual error made up of errors of measurement, observing, etc., and film displacement. From a discussion of many plates from Greenwich it appears that the average probable error of the measured position of a star on a single plate is $\pm 0{\cdot}0008$ mm. Film displacement being only a part of the total it follows that this must be the upper limit of the probable error of film displacement. In the Kapteyn system of observation, the photographs at the two epochs are taken on the same plate, which is stored away during the interval and developed after the second exposure. It was arranged that the images fell near each other (within 1 mm.—they were, however, too small for the Ross effect to come into action) and only the small differences separating the images were measured, any film displacement which would affect both images equally, consequently disappearing. This method has now been given up in favour of single plates, but a number of the Kapteyn pairs have since been measured treating each photograph as a separate plate. From a discussion of the residuals of some 300 plates the film error is $\pm 0{\cdot}0003$ mm.

The Faraday Society, January 15.—Sir Robert Robertson, president, in the chair.—E. W. J. **Mardles**: Study of the reversible sol to get transition in non-liqueous systems. Pt. 1: The change of viscosity with time during gelation. The viscosity value of a sol during its gelation is dependent on the method and conditions of its determination, and since the system is heterogeneous, it loses its real significance. The change of apparent viscosity with time during the gelation of a sol of cellulose acetate in benzyl alcohol can be expressed by an empirical formula. The temperature, when the rate of gelation becomes nil, is regarded as the maximum gelation temperature, since above it the sol is relatively stable with time and below it a part or whole of the dispersed particles aggregate to form a gel structure. The relation between the maximum gelation temperature and concentration resembles that between temperature and the saturation concentration for crystalloids. Pt. 2: Viscosity changes associated with the gel to sol transition. These have been measured at various temperatures and with different concentration systems of cellulose acetate in benzyl alcohol. The viscosity at first rapidly diminishes, the rate of change becoming smaller until a constant value is obtained. The minimum temperature at which there is a complete return to the original viscosity of the sol without mechanical treatment is termed the minimum solation temperature. Mechanical treatment hastens solation in the same way that it retards gelation. The time taken for a system to attain constant viscosity or mobility depends on the previous treatment of the gel. The hysteresis effect observed during the sol$\rightleftharpoons$gel transition can be measured by the difference in the temperature of minimum solation from that of maximum gelation, and the cause of it has been ascribed to the different conditions of the particles in the gel and sol state.—E. W. J. **Mardles**: Changes of volume and refractive index associated with (*a*) the formation of organosols and gels; (*b*) the reversible sol to gel transition. In general, the volume changes are largest (*a*) at the lower concentrations, (*b*) with the best solvents and optimum solvent mixtures, and (*c*) at higher temperatures. They are much smaller than those observed by other workers for hydrosols and gels. The reversible sol to gel transition is associated with a small volume change which varies with time as in the case of the Tyndall number changes. There are also indications of a change of refractive index corresponding to the volume and Tyndall number changes during the reversible sol to gel transition.—E. W. J. **Mardles**: The scattering of light by organo-sols and gels of cellulose acetate. Measurements of the change with temperature of the Tyndall number of sols and gels of cellulose acetate in benzyl alcohol during the reversible sol to gel transition show that with fall in temperature of the sol the rate of change is small until a certain critical temperature, after which it increases with acceleration. Eventually there may be a point of inflexion on the curve, the position of which depends on the rate of cooling, and is determined by the formation of a firm jelly structure which inhibits the development of opalescence. The Tyndall number of a gel is a function of the mechanical treatment as well as rate of gelation and it varies with time, the rate of change rapidly diminishing in absence of mechanical treatment. A gel tends to increase its Tyndall number, and mechanical treatment may induce opalescence. The Tyndall number-concentration curve contains a maximum which tends to disappear at higher temperatures, thus the size of the particles in a gel structure is a function of the concentration and the temperature at which it was formed. The curve resembles Tammann's curve relating the number of crystallisation nuclei, or rate of crystallisation, with the degree of supersaturation.—J. R. **Partington** and W. J. **Shilling**: The variation of the specific heat of air with temperature. The velocity of sound in the gas contained in a large silica tube arranged as an electrically heated furnace was measured at intervals of approximately 100° C., from room temperature up to 1000° C. The values obtained up to 700° C. lie practically on the line given by $C_v = 4{\cdot}849 + 0{\cdot}000358T$ grm. cal. Above 700° C_v appears to increase more rapidly with temperature, but at present the values above 800° are uncertain.

Royal Anthropological Institute, January 16.—Dr. F. C. Shrubsall, treasurer, in the chair.—Mr. M. **Addison**: Human heads carved in steatite from Sierra Leone. The Mende tribes, in whose territory the heads were obtained, know nothing of their origin, but although the heads exhibit certain characteristics, such as nose- and ear-rings and long drooping moustaches, which do not occur among the inhabitants of the district at the present day, it is not probable that they are of a very high antiquity, their age possibly being two or three hundred years. Among the Mende the heads are used for magical purposes, and, placed on mounds in the fields, are thought to increase the fertility of the crops.—F. W. H. **Migeod**: The Bedde group of tribes of Northern Nigeria. Though extending from Lake Chad as far as the City-State of Hadeija the Bedde are not a well-known people. They have the legend that they originated in Yemen in Arabia and that they were the first people driven out of Arabia in consequence of their refusal to accept Mohammedanism. The Westernmost branch of the Bedde, the Awuyoka, have a list of kings going back to the 12th century. The language shows no traces of an Arabian origin. The Bedde live in round huts grouped in compounds, and formerly all the towns were surrounded by a rectangular mud embankment, but most of the defensive works are now in ruins. Swords, spears, and bows and arrows are the offensive weapons. Children are named by the father, but there are fixed names for twins, male and female. Marriage may take place into any family. Corpses are buried on the right side with head to the south and so facing east, the hands being drawn down and placed together. The Bedde seem to be very superstitious and to believe in omens. They are divided up into animal tribes such as Leopard, Hippopotamus, etc., which form a bond outside family life. No worship is offered to the tutelary animal, but it must not be killed or eaten by those who bear its name. The people now nearly all wear gowns of cotton like the Hausas or Bornuese. They slash or cut their faces with a main design and subsidiary marks. The men shave their heads but the women indulge in fancy head-dressing. They are not a short race. They usually have broad faces, some being very broad across the cheek-bones, and usually have heads low above the ears and receding foreheads; but there is great variety.

Royal Microscopical Society, January 17.—Prof. F. J. **Cheshire**: The early history of the polariscope and the polarising microscope (presidential address). The early history of double refraction, from 1669, when Bartholinus first received specimens of spar from the Bay of Roërford in Iceland, up to 1808, when Malus, by a happy chance, made the wonderful discovery of polarisation by reflection, and the identity of the light thus produced with the refracted beams given by Iceland Spar, was discussed. The difficulty was considered of explaining double-refraction on Huygens' undulatory theory, disposed of by Fresnel in 1821, who abandoned the theory of longitudinal vibrations, and substituted transverse ones for them, after having proved, with Arago in 1816, that oppositely polarised beams do not interfere in the same way that Young had shown beams of ordinary light do. The work of Brewster and Biot was referred to, and some account given of the extraordinary amount of work done between Malus's discovery in 1808, and the invention of the Nicol prism in 1828, from which date the modern microscope dates. In the early days the polarising microscope was employed primarily for the examination of general objects, whereas the application of the petrological microscope to the systematic study of rock-sections dates no further back than 1870. Various forms of polariscopes, including a remarkable one invented by Airy in 1831, were described, and possibilities of further improvements discussed. It was urged that the work of Herapath and others in the production of artificial tourmalines should be again taken up. Finally, to meet the present difficulties of supplying students' microscopes it was urged that teachers and manufacturers should come to an agreement as to the simplest possible designs with which the students' work could be done.

PARIS.

Academy of Sciences, January 8.—M. Albin Haller in the chair.—A. **Haller** and R. **Lucas**: Study of the absorption in the ultra-violet of a series of derivatives of camphor. Certain derivatives of camphor of the type $C_8H_{14}\left<\begin{matrix}C=CH.R\\CO\end{matrix}\right.$ show anomalies in their optical properties (dispersion, molecular refraction, rotatory power) compared with the corresponding reduction products. Seven substances of the first type and two of the second have been studied from the point of view of their ultra-violet absorption spectra, and the results given in the form of the curves suggested by Lord Rayleigh.—P. A. **Dangeard** and Pierre **Dangeard**: The vitality of Aucuba leaves preserved in a vacuum. An adult leaf of Aucuba placed in a vacuum and exposed to light during six months preserved all its cells alive, and no important difference could be detected between the structure of these cells and that of the leaves remaining on the tree.—Th. **Anghelutza**: The representation of functions of one real variable.—Gaston **Julia**: Rational substitutions with two variables.—J. F. **Ritt**: Rational permutable functions.—G. V. **Pfeiffer**: A special method of integration of partial differential equations of the first order.—Torsten **Carleman**: The effective calculation of a quasi-analytical function, the differentials at a point being given.—Emile **Borel**: Remarks on the preceding note of M. Torsten Carleman.—Paul **Dienes**: Transfinite series of real numbers.—Tadé **Wazewski**: Measurable *ensembles*.—G. **Bratu**: Curves defined by recurrent series.—J. **Chuard**: Some properties of cubical networks traced on a sphere.—David **Wolkowitsch**: The infinitely small movements at a point of an elastic body admitting a plane of symmetry.—Charles **Frémont**: The influence of the velocity of impact in the calibration of dynamometer springs. The experiments were arranged with falling weights so chosen that the product of the weight by the height fallen remained constant. The deflections of the spiral spring increased as the velocity of impact diminished: the anomalous result is due to the inertia of the spring.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the third quarter of 1922.—R. **Lucas**: Natural and magnetic rotatory power. If a substance possessing natural optical activity is suitably placed in a magnetic field, the substance acquires a complex rotatory power. The question as to whether there is simple additivity of the two rotatory powers, or whether the two phenomena exert a mutual influence on each other is investigated mathematically, and the conclusion is arrived at that the change in the natural rotatory power produced by the action of the magnetic field would be too small to put in evidence experimentally.—A. **Catalán**: The structure of the arc spectra of the elements of columns VI and VII of the periodic table.—G. **Reboul** and P. **Blet**: The different aspects of the electrical discharge in crystals.—A. **Grumbach**: Batteries with fluorescent liquid. If two platinum electrodes dip into a fluorescent solution and one of them is illuminated, an electromotive force is produced which varies with time. Some experimental results with solutions of uranine in water are given proving that Goldmann's explanation of the phenomenon is inadequate.—A. **Bigot**: The action of heat on kaolins, clays, etc. Ceramic plastic materials, under the action of heat, harden without dehydration and without change of volume. The colloidal plasticity is reduced by this heating.—Roger G. **Boussu**: A method for studying the velocity of formation of precipitates.—F. **Bourion**: The normal acids of Berthelot and the theory of ions.—Henri **Bénard** and Albert **Laborde**: The estimation of albumen by nephelemetric methods.—Mlle. S. **Veil**: The evolution of the molecule of ferric hydroxide in water: the dehydration of ferric hydroxide by ignition or by heating with water in sealed tubes to temperatures between 120° C. and 210° C. has been co-ordinated with the changes produced in the magnetisation coefficient.—B. **Bogitch**: The removal of sulphur from metals by lime. A study of the decomposition by lime, in the presence of carbon, of some metallic sulphides dissolved in the fused metal. Copper, nickel, iron, and manganese were studied, the action of lime and basic slag being examined separately. A mixture of lime and fluorspar gave the best results.—Mlle. de la **Paulle**: The estimation of potash as alum.—R. **Douris** and G. **Beytout**: The mercuric compounds of hexamethylenetetramine.—Carl **Stormer**: Results of the photogrammetric measurements of the aurora borealis of March 22-23, 1920. The greatest altitude measured was 750 kilometres; in no case was the height less than 100 kilometres.—Octave **Mengel**: New seismotectonic views, resulting from the earthquakes felt between August and December 1922, in the eastern part of the Pyrenees.—M. **Stefanescu**: The growth in two opposite directions, and the marks of friction and pressure, of the molars of mastodons and elephants.—L. **Joleaud**: Sub-fossil hippopotami of Madagascar and the recent geographical connexions of this island with the African continent.—Albert **Baldit**: The undulatory movements of the atmosphere and their utilisation in aviation without a motor.—Jean **Mascart**: The quantity of heat received by the earth in the course of the seasons.—F. **Diénert**: Considerations on the formation of springs.—J. **Cluzet** and A. **Chevallier**: The use of thorium emanation in inhalation. By utilising radiothorium from the sludge derived from the Echaillon springs, thorium emanation has been used directly by inhalation, and the therapeutic results obtained proved to be comparable with those given by other methods of treatment.—Jean **Bathellier**: The fungus gardens of *Entermes Matangensis*. These ants cultivate fungi (identified as a Xylaria) in special chambers.—G. **Marinesco**: Oxidising ferments and thermogenesis.—F. **Vlés**, J. **Dragoin**, and M. **Rose**: Researches on the hydrogen-ion concentration arrest of egg division in the sea urchin.—L. J. **Simon** and L. **Zivy**: The mixture of tartrates and phosphates regarded as buffer substances. The antagonistic action of calcium chloride.—Emile **Misk**: Tin in the human organism. Reference is made to the frequent presence of traces of tin in preserved foods. Tin appears to be present in the human body, the largest proportion being found in the liver. From the physiological point of view it is interesting to note that the body appears to contain normally at least as much tin as zinc.—Boris **Ephrussi**: The spermatogenesis of *Balanus perforatus*.—A. **Trillat**: The different properties of dry or liquid bacterial dusts.—C. **Levaditi** and S. **Nicolau**: Inoculation of the herpetic virus in the genital organs of the rabbit. Transmission of the herpeto-encephalitic infection by sexual contact.

Official Publications Received.

Memoirs of the Asiatic Society of Bengal. Vol. 8, No. 1: Ismailitica. By W. Ivanow. Pp. 76. (Calcutta: Asiatic Society of Bengal.) 2 rupees; 3s.

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1922. Pp. 23. (Bristol.)

Diary of Societies.

MONDAY, FEBRUARY 5.

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

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. E. Griffiths: The Relation of Diseases of the Gall Bladder to the Secretory Function of the Stomach and Pancreas.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—A. Collis-Brown: Practical Notes on Inspection.

INSTITUTE OF TRANSPORT (at Institution of Electrical Engineers), at 5.30. H. N. Gresley: Wagon Stock on British Railways.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—J. Coxon and others: Discussion, The Supply of Steady D.C. for Telephonic and other Purposes.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Miss May Sinclair: Primary and Secondary Consciousness.

ROYAL SOCIETY OF ARTS, at 8.—Dr. H. P. Stevens: The Vulcanisation of Rubber (Cantor Lectures) (1).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Engineers' Club, Coventry Street), at 8.—G. T. Bray and F. Major: The Estimation of Fat in Casein.—Dr. E. Fyleman: Explosions in Liquid Air Rectification Plant.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presidential Address to Students and Presentation of Prizes.

TUESDAY, FEBRUARY 6.

AIR CONFERENCE (at the Guildhall, E.C.), at 10.30.—Maj.-Gen. Sir W. J. Brancker: The Position of Air Transport To-day.—Comdr. C. D. Burney: A Self-supporting Airship Service. At 2.45.—Air Vice-Marshal Sir W. G. H. Salmond: The Progress of Research and Experiment.—Col. A. Ogilvie: Gliders and their Value to Aeronautical Progress.—C. R. Fairey: Seaplanes.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Annual General Meeting) (at the Holborn Restaurant), at 2.30.—Prof. W. E. Garner: Theory of Combustion of Gaseous and Liquid Fuels.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—R. D. Oldham: The Character and Cause of Earthquakes (2).

ROYAL SOCIETY OF ARTS (Dominions and Colonies and Indian Sections), at 4.30.—Sir Richard A. S. Redmayne: The Base Metal Resources of the British Empire.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions made to the Society's Menagerie during the months of November and December 1922.—E. G. Boulenger: Account of Experiments on Amphibians and Insects at Vienna.—C. A. A. Dighton: Coat-colour in Greyhounds.—E. L. Gill: The Permian Fishes of the Genus Acentrophorus.—Dr. C. F. Sonntag: The Vagus and Sympathetic Nerves of the Terrestrial Carnivora.—E. P. Allis, Jr.: The Postorbital Articulation of the Palato-quadrate with the Neurocranium in the Cœlacanthidæ.—Dr. G. S. Giglioli: The Linguatulid Arachnid, *Raillietiella furcocerca* (Diesing, 1835), Sambon, 1922.—Rita Markbreiter: Some *Microfilaria* found in the Blood of Birds dying in the Zoological Gardens, 1920-1922.

INSTITUTION OF CIVIL ENGINEERS, at 6.—D. H. Remfry: Wind-Pressures, and Stresses caused by the Wind on Bridges.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Major O. Rutter: The Natives of North Borneo.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.

WEDNESDAY, FEBRUARY 7.

AIR CONFERENCE (at the Guildhall, E.C.), at 10.30.—General Discussion on the Papers read in the morning of February 6. At 2.45, General Discussion on the Papers read in the afternoon of February 6.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. G. Keynes: Chronic Mastitis.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—G. V. Douglas: The Geological Results of the Shackleton-Rowett (*Quest*) Expedition.

NEWCOMEN SOCIETY (at Alpine Club), at 5.30.—G. P. Baker: East Indian Cotton Prints and Paintings of the 17th and 18th Centuries.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—J. Hollingworth: The Measurement of the Electric Intensity of Received Radio Signals.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (Annual General Meeting) (at Chemical Society), at 8.—Presidential Address.—O. Jones: Notes on the Examination of Preserved Meats, etc.—E. Griffiths-Jones: Titanium in Nile Silt.

ROYAL SOCIETY OF ARTS, at 8.—C. R. Darling: Electrical Resistance Furnaces and their Uses.

FELLOWSHIP OF MEDICINE (at Royal Society of Medicine), at 8.30.—J. P. Lockhart-Mummery: Diverticulitis.

THURSDAY, FEBRUARY 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. I. M. Heilbron: The Photosynthesis of Plant Products (2).

ROYAL SOCIETY, at 4.30.—Prof. L. Bairstow, Miss M. B. Cave, and Miss E. D. Lang: The Resistance of a Cylinder moving in a Viscous Fluid.—G. I. Taylor: The Motion of Ellipsoidal Particles in a Viscous Fluid.—L. F. Richardson: Theory of the Measurement of Wind by Shooting Spheres Upward.—Prof. W. E. Dalby: Further Researches on the Strength of Materials.—L. C. Jackson and Prof. H. Kamerlingh Onnes: Investigations on the Paramagnetic Sulphates at Low Temperatures.—L. C. Jackson and Prof. H. Kamerlingh Onnes: Investigations on the Paramagnetism of Crystals at Low Temperatures.—Prof. E. Wilson: The Susceptibility of Feebly Magnetic Bodies as affected by Tension.—W. D. Womersley: The Specific Heats of Air, Steam, and Carbon Dioxide.

WOMEN'S ENGINEERING SOCIETY (26 George Street, W.1.), at 6.15.—E. W. C. Kearney: The Kearney High-speed Railway.

OPTICAL SOCIETY (Annual General Meeting) (at Imperial College of Science and Technology), at 7.30.—Sir Frank Dyson: Large Telescopes (Presidential Address).—Discussion on paper by F. W. Preston: The Properties of Pitch used in Working Optical Glass. A new *prismatic astrolabe* designed at the Admiralty Research Laboratory exhibited and described by Commdr. T. Y. Baker.

CAMERA CLUB, at 8.15.—C. H. L. Emanuel: Notes of a Collector of Prints and Drawings.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers, Inc.), at 8.30.—Miss M. L. V. Gayler: The Investigation of the Constitution of Alloys.

FRIDAY, FEBRUARY 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Anniversary.

PHYSICAL SOCIETY OF LONDON (Annual General Meeting) (at Imperial College of Science and Technology), at 5.—Sir William Bragg: The Crystalline Structure of Anthracene.—Capt. H. Shaw and E. Lancaster-Jones: The Eötvös Torsion Balance.—H. W. Heath: Demonstration of the Flame Phone.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. L. R. Rawling: Remote Effects of Gun hot Wounds of the Head.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Adjourned Discussion on Symposium of Papers on Indicators:—L. Pendred: The Problems of the Engine Indicator.—Prof. F. W. Burstall: A New Form of Optical Indicator.—W. G. Collins: Micro-Indicator for High-Speed Engines.—H. Wood: R.A.E. Electrical Indicator for High-Speed Internal-Combustion Engines, and Gauge for Maximum Pressures.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Prof. F. C. Lea: The Effect of Temperature on the Properties of Engineering Materials.

PHILOLOGICAL SOCIETY (at University College), at 8.—J. Hodgkin: Macaronic Poetry.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir John Russell: "Rothamsted" and Agricultural Science.

PUBLIC LECTURES.

SATURDAY, FEBRUARY 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: Insect Pests and their Control.

MONDAY, FEBRUARY 5.

KING'S COLLEGE, at 5.—N. B. Jopson: The Original Home of the Slavs.

UNIVERSITY COLLEGE, at 5.—Sir John Russell, and staff of the Rothamsted Experimental Station: The Micro-Organic Population of the Soil (succeeding Lectures on February 7, 12, 14, 19, 21, 27, March 1, 5, and 7).

TUESDAY, FEBRUARY 6.

GRESHAM COLLEGE, at 6.—W. H. Wagstaff: Geometry (succeeding Lectures on February 7, 8, and 9).

WEDNESDAY, FEBRUARY 7.

KING'S COLLEGE, at 5.30.—Dr. J. S. Haldane: The Fundamental Conceptions of Biology.

THURSDAY, FEBRUARY 8.

UNIVERSITY COLLEGE, at 5.30.—G. A. Sutherland: The Acoustics of the Auditorium. (Succeeding Lectures on February 15 and 22.)

CENTRAL LIBRARY (Fulham), at 8.—Mrs. G. Skelton: Women and Industry.

FRIDAY, FEBRUARY 9.

UNIVERSITY COLLEGE, at 8.—Miss E. Jeffries Davis: The Evolution of London (succeeding Lectures on February 16 and 23).

SATURDAY, FEBRUARY 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: Household Appliances of a Hundred Years Ago.

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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*" To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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Science Teaching.

IT has long been felt that a great defect in our secondary school education has been that boys and girls may pass on to the universities or out into the world of business without having received any instruction in science or any skilled guidance in the pursuit of their scientific hobbies. It is owing probably to a defect of this kind in the education of many of our public men that we have so often to complain of the indifference that is shown to pressing necessities for the better encouragement and endowment of scientific research. It is true that many of our large public schools are now provided with first-rate teachers of science and with well-equipped scientific laboratories, so that the boy or girl who takes the modern side may receive a really good foundation of scientific knowledge. It is also true, however, that, owing to the tyranny of our scholarship system the classical boys in the upper forms of secondary schools have not time to devote to instruction in any branch of science, and for the same reason the education of boys in elementary science is too frequently neglected, both in the preparatory schools and in the lower forms of secondary schools.

What is wanted in education is the cultivation of the idea that no modern citizen can be considered really well educated who has not gained some knowledge of the natural phenomena of the world in which he lives, and of the body which is the temple of his soul. If we could persuade all parents of the truth of this conception, they would not be satisfied with the education of their children unless they have had, at least in the preparatory school or in the lower forms of the secondary school, some instruction in science.

There has been some difficulty, however, in coming to an agreement as to the best and most practical form in which science should be taught in the lower forms; and it is, therefore, with great pleasure that we welcome the valuable report, just published, of a sub-committee of the Science Masters' Association.[1] The fundamental principle that underlies the method of education suggested in the report is that "the work should be done by the boys themselves with as little help as possible from the master in charge"; and accordingly, a syllabus is drawn up of subjects which, experience has shown, can be studied effectively and with simple appliances in school life. Included in the report there are also an interesting and valuable syllabus of subjects arranged as a calendar of work, and three specimens of lessons that may be given in natural history.

All this is excellent and worthy of most careful study

[1] Elementary Science, Nature Study, and Practical Work in Preparatory Schools and the Lower Forms of Secondary Schools. Report of the Sub-Committee appointed by the Science Masters' Association, 1922. (Oxford: University Press. Price 1s.)

and consideration by teachers in schools. The point in the report to which objection may be made is the rigid declaration that "set lectures giving mere information in a didactic manner should be avoided." Most teachers of science would agree that at an early stage the teaching of science should be mainly practical and objective. If it is not, the true spirit of scientific knowledge is lost. But why should the didactic manner be avoided? In the course of study in zoology, for example, why should there not be occasional lectures on some of those wild beasts of the world which naturally excite the interest of boys and girls. Lectures on whales, on kangaroos, on the great carnivores, on tropical insects, or even on the fauna of coral reefs, would surely be stimulating and instructive. Entirely to avoid didactic instruction is to make the teaching of science too parochial in character and to leave unsatisfied the thirst for knowledge of the wonders of the world beyond our own shores.

The new method may be admirable as a substitute for the older dry-as-dust didactic teaching, but it tends to lead into the new danger of discouraging boys and girls from reading about natural phenomena beyond the reach of their personal observation and about the thoughts and discoveries of the great men of science.

Human Character.

Human Character. By Hugh Elliot. Pp. xvi + 272. (London: Longmans, Green and Co., 1922.) 7*s.* 6*d.* net.

WE are accustomed to judge of a man's character by his behaviour, that is to say, by the manner in which he reacts to the countless vicissitudes of everyday existence. In our experience these reactions differ according to the individual, and we interpret this variability of response by saying that the characters of the individuals affected are correspondingly diverse. Although character is an attribute of the man himself, it can only be known by the man's actions, and is a rough description of the mental and nervous constitution on which the reactions depend. This constitution is partly inborn, partly acquired. The pattern of the cells and nerve paths which make up the central nervous system is already laid down before birth, but the resistance which any impulse meets with in its passage through the central nervous system is the resultant not only of the inherited pattern, but also of experience, every reaction which has occurred having left some trace of its passage and produced facilitation along certain paths and blocking of certain other paths.

Character is thus a product both of nature and of nurture, the former supplying potentialities of behaviour, the latter limiting and modifying the extent to which any given reaction may take place. Although character is a question of the arrangement and resistance of a complex system of neurones, the only possible way of describing it is in terms of the reactions which it is able and wont to produce. Without taking a dynamo to pieces and measuring the physical properties of its various parts, the only method by which we could describe its potentialities would be by making it work and finding out what current and what electromotive force it gave us at varying speeds of rotation, *i.e.* by its performance; and the same holds good for any attempt to describe under the term of character the complex structural arrangements which determine the reactions of a man. Character itself we cannot with any accuracy describe or classify, but we can analyse the different factors, mental or physiological, which are involved in its formation and determine behaviour. This is the manner adopted by Mr. Hugh Elliot in the book now before us.

Since character determines behaviour, it is possible to form an idea of the essential nature of human character by analysing the motives which determine human action. The older philosophers (and their teaching is reflected in current thought) were wont to draw a marked distinction between the actions of animals, which were determined by instinct, and those of man, which were guided by reason; whereas we have now recognised that the intellectual processes of reasoning have very little to do with behaviour. Although the emotions have long been described as the springs of action, the preponderating and almost exclusive rôle of emotions in determining human activities has only been fully recognised during the last twenty years. Emotions are the representation in consciousness, the subjective side, of the complex series of automatic reactions which in animals we call instincts and which in their case we only occasionally endow with emotional attributes. Thus the quest for food, flight from an enemy, pursuit of a mate, are all automatic reactions which are shared by man with the lower animals, but in the former case we say they are due to the emotions of hunger, fear, or love.

In the first chapter of this book, which Mr. Elliot entitles "General Principles," the author emphasises the all-importance of the emotional states in the determination of behaviour. Man's life thus becomes a series of instinctive reactions differing from those of the lower animals only in their greater complexity, and in the extent to which they are varied as the result of individual training or education. Reason does not dictate behaviour. Party government would be impossible if this were the case, nor would two nations like the French and English advocate diametrically opposite methods of dealing with the same problem. Reason is but the instrument for the safer and more successful carrying out of a reaction which will satisfy the prevailing emotion, and it is to the emotional conditions of the electors or of different nations that politicians and statesmen have to appeal if they wish to get support for any particular line of action. Volition itself is another word for desire. A man with a strong will is one in whom all the faculties of the mind are slaves to the satisfaction of a dominant desire, which may be easily attained or may take years for its achievement. The author points out that what a man does is the resultant of what he feels, and since feelings are themselves dependent on external conditions of the individual, character is but an abstraction, a name for the average mental manifestations and not representing anything fixed or constant.

Theoretically it might be thought possible to build up a logical account of character, starting from the primitive instincts tending to the preservation of life, to reproduction, and to the association with other individuals in communities (the herd instinct), by showing how these are modified to produce the manifold variation of impulsive behaviour observed in man. Such an attempt would, however, involve us in constant cross-reference, since every quality of the mind is bound up with other qualities, just as every part of the brain is associated in its activities with those of all other parts. The only method left is that adopted by the author, namely, taking the more complex emotional conditions, to analyse their composition, their relationship to other mental states, and their manifestations in conduct. Such a method renders it difficult to preserve logical continuity in the treatment of the problem. Each chapter becomes an essay in itself, as is evident from a consideration of the headings in the table of contents. The first seven chapters, for example, are labelled as follows: General Principles, The Major Passions, Egoism, Love, Social and Moral Feeling, Jealousy, Religion.

There are altogether twenty-two chapters, but the treatment is much more connected than would appear at first sight from the headings just detailed. Throughout the book the point of view of the author is that of the educated amateur, so that the reader feels that he is capable of following the arguments and appreciating them critically, and indeed that he is entitled to differ from the author without presumption. After all, the most readable books are those in which the reader is only half in agreement with the author, so that he is incited to think for himself, and to form his own conclusions on the subjects dealt with. It will do no one any harm to try to analyse in the same manner in which the author has accomplished it the motives for his own actions and for those of other people. It may indeed tend to make reason play rather a larger part than has hitherto been the case.

It is curious that the author at the beginning of the work abandons the analytic method when speaking of the moral feelings. He says: "The moral emotions are a deep and powerful instinct, buried in every mind, and so much part of our constitution that we are almost unaware of their very existence. We refrain from wrong-doing as the result of a deep emotion which controls our actions, very often unknown to ourselves." This is in other words the popular idea of conscience, which is regarded as implanted in man from his birth. But surely, when the author speaks of "wrong"-doing he is begging the whole question. The moral instinct is the impulse to act in accordance with the rules of the tribe of which the individual is a member, and is developed by education, in its broadest sense, from the herd instinct. On this instinct depend the appreciation of approval and the seeking of support from the other members of the community. By education, by mimicry, by the repetition of enforced actions, by the experience of the painful results of some and the pleasurable results of other actions, the herd instinct is so moulded that the easiest reaction to commonly recurring circumstances is one that is in accordance with the rule of the tribe, and any anti-social action is attended with mental discomfort or anticipation of punishment or disapproval. This is what is commonly called conscience. The moral sense will thus be quite different in men of different races, according as they have been brought up in a Hindu or Christian community or among savages. The potentialities of development of this moral sense, this *Sittlichkeit*, will vary from individual to individual, but the content of the sense and its results in action will depend on the environment of the man from his birth.

The book is copiously illustrated with quotations from Shakespeare, Dante, and Goethe. The author points out that great writers, far more than men of science, penetrate human nature, and that of all writers Shakespeare possessed the most profound insight into character. The upshot of the whole work is that a man's character depends on his feelings. Feelings are the springs of action; education is above all a development and training of feelings. It matters more what a man does than how he does it, and it is probably on this account that the English system of education, so deficient on the intellectual side, can boast of results in many ways more successful than those achieved by the Lycée or Gymnasium.

E. H. S.

The Arabs of the Sudan.

A History of the Arabs in the Sudan: and Some Account of the People who preceded them and of the Tribes inhabiting Dárfūr. By H. A. MacMichael. Vol. 1. Pp. xxii+347. Vol. 2. Pp. viii+488. (Cambridge: At the University Press, 1922.) 2 vols. 90*s*. net.

THE two volumes before us present the result of Mr. MacMichael's investigations in the Northern Sudan carried on for nearly twenty years, and they may be regarded as the logical continuation of his earlier work (published in 1912) on the Arabs of Kordofan. The present work deals with all those Sudanese tribes in which Arab blood preponderates, or at least warrants the popular conception of them as Arabs.

Mr. MacMichael's area of study—roughly north of 12° N. and west of 25° E.—is so entirely his own, his conclusions so largely the result of original field work, that any detailed criticism is impossible. All that the reviewer can do is to give some idea of the scope of the book, the author's general conclusions, and where possible indicate how far these agree or disagree with the results of workers in other parts of the Sudan.

The plan of the book is unusual; the second volume consists of the translations of thirty-two native manuscripts, for the most part *nisba* "pedigrees," with explanatory notes and genealogical trees. The first volume, with the exception of sections dealing with the early history of the Nile Valley, and the non-Arab races of Darfur, is devoted to a series of dissertations or essays based on the data contained in the manuscripts in volume 2, and the study that the author has made of literary sources both Arabic and European.

Wearisome as these *nisba* are to read—and the student will be inclined to echo the sixteenth-century writer of document BA, "the knowledge of the pedigrees of persons who are unrelated to yourself is of no use"—their value is increased by their rarity, for though many Sudan Arabs are prepared to produce fragments of paper which they regard as of genealogical interest, relatively few documents of real historical value have survived the ravages of white ants and the accidents of the nomad life. Moreover, of those that did exist half a century ago, very many were burnt during the Dervish rule by the orders of the Mahdi, who feared that research might tend to invalidate his pretensions to be the Expected One, and by the Khalifa, a Baggara from Darfur who was interested in genealogy to the extent only of not desiring to appear less nobly born than those over whom he ruled.

Not all the manuscripts are *nisba*: there is a "History of the Fung Kingdom" (MS. D7) of far more general interest, while somewhere between these and the "pedigrees" come the MSS. numbered DI and D3. The third part of the former, probably dating from the eighteenth century, contains much of general ethnological interest, while the latter, a series of biographies of holy men of the Fung period, written early in the nineteenth century, has considerable social and folklore value.

The first three chapters, dealing with the pre-Muhammadan inhabitants of the Sudan, go far back in time. Mr. MacMichael seems concerned to prove that there was a considerable inflow of Arabians into Egypt and the Sudan so far back as the Old Kingdom, but there is really no sufficient evidence for this, nor from the point of view of the present volumes is it of any importance, this alleged very early Arabian influence being ignored in the remainder of the work. The next two chapters deal for the most part with the Nubians and Beja and contain much that is interesting and suggestive, but the reviewer may be allowed to point out that the author is incorrect in attributing to him the view (1, p. 35) that "the Hadendoa are representatives of the Beni Amir stock modified chiefly by miscegenation with the tall negroes of the Nile Valley, and also, in all probability, with the . . . round-headed Armenoid population. . . ." There can be little doubt that it is Armenoid blood that is responsible for certain of the physical characters of the Hadendoa; negro influence has been but slight. In any case these three chapters are introductory only; they contain none of the author's own observations, so that they stand apart, and the critical attitude which they provoke rapidly dies down on reading the rest of the book.

The remainder of part 1 forms a most valuable introduction to the ethnology of the non-Arab races of Darfur; here Mr. MacMichael has done service not only by bringing together the scattered notices from literature, but also by the account he gives of the social organisation and religious rites which he has himself observed among the Dagu, the Fur, and the dwellers on Jebel Midob. Among these tribes, as well as among some of their even less known neighbours, rain-making ceremonies are still of importance, the rain-maker being a woman and descent being in the female line; moreover, in a general way their religious ideas, so far as it is possible to judge on present information, seem akin to those of the Nuba of Southern Kordofan, as observed by the present writer. This fact has not escaped Mr. MacMichael; it might have been added that the work of Tucker and Myers (Journ. Roy. Anthrop. Inst., 1910) suggests a definite physical relationship. Combining the information he collected from the various tribes of Darfur, Mr. Mac-

Michael concludes that the two main ethnic strains in the country are the negro and the hamitic, the latter being, at least in part, a result of the pressure exerted by Arab immigrants into North Africa upon the Berber tribes. Thus originated the ruling aristocracy of the states fringing the Sahara to the west of Lake Chad, while the Tibbu are to be regarded as an early Libyo-Berber mixture that has come to form the basis of the population of Northern Darfur, the negro element predominating in the south. It must, however, be remembered that cultural influence, perhaps relatively ancient, has come in from the east, as is evidenced not only by legends of origin but also by the very striking resemblance in the vocabularies of such peoples of Darfur as the Midob and Birked to those of the Barabra of the Nile Valley, and that with this, there was probably introduced a strain of foreign blood.

Turning now to the Arabs with whom the main bulk of the work is concerned, Mr. MacMichael begins by tracing their progress through Egypt in the Middle Ages. This is no easy matter, for even in the ninth century the historian, el Baladhuri, admits that there were great differences of opinion. Here may be quoted a dictum of the author of MS. D I: "The tribes of the Arabs who are in the Sudan, other than these [the Nuba, the Abyssinians, and the Zing], are foreigners, and have merely mixed with the tribes mentioned above and multiplied with them. Some of them have retained the characteristics of the Arabs, and the element of Nuba and Zing that is interspersed among them has adopted the Arab characteristics; and on the other hand there have been some Arabs who have become fused with the Nuba and the Zing, and adopted their characteristics; but in each case they know their origin."

Here, in brief, is the history of much of the Arab Sudan, and even if it be doubted that "in each case they know their origin" a great deal of Mr. MacMichael's research does but amplify and confirm his Arab forerunner. The whole process can be followed particularly well in the case of the Guhayna (Juhaina). In the pre-Islamic period they occupied Nejd and the neighbourhood of Medina, where a section dwell to this day. Many migrated to Egypt, taking part in the conquest with other sections of the Ḳuda'a, while two hundred years later they formed part of a force invading the Beja country. Some of them seem to have reached Aswan by the ninth century; by the fourteenth century they had penetrated far into Nubia, and it was the Guhayna who more than any other tribe brought about the dissolution of the Christian kingdom of Dongola.

"At first the kings of the Nuba attempted to repulse them, but they failed; then they won them over by giving them their daughters in marriage. Thus was their Kingdom disintegrated, and it passed to certain of the sons of the Guhayna on account of their mothers according to the custom of the infidels as to the succession of the sister or the sister's son. So their Kingdom fell to pieces and the A'rab of Guhayna took possession of it. But their rule showed none of the marks of statesmanship because of the inherent weakness of a system which is opposed to discipline and the subordination of one to another. Consequently they are still divided up into parties and there is no vestige of authority in their land, but they remain nomads following the rainfall like the A'rab of Arabia. There is no vestige of authority in their land, since the result of the commingling and blending that has taken place has merely been to exchange the old ways for the ways of the Bedouin Arab." Thus Makrizi in a passage not included in de Slane's translation.

It was this dual policy of following the rainfall and of inter-marriage that led to the rapid spread of the stock, so that a sixteenth-century author, or more probably copyist, writes of a total of "fifty-two tribes in the land of Soba on the Blue Nile under the rule of the Fung," while there were even more in the west, including Bornu. So at the present day all the Baggara, including those of Darfur and Wadai, regard themselves as united in the common bond of Guhayna ancestry. It is in this sense that the Guhayna constitute one of the great moieties of the Sudan Arabs, yet it must be remembered that in the Sudan the tribal name Guhayna is used in a narrow as well as a broad sense. In the former it is restricted to certain nomads inhabiting the Sennar Province; it is only in the widest sense and by much manipulation of genealogies that it is stretched to include the Baggara and the vast group of camel nomads in Kordofan, all of whom if pressed will say that they are descended from Abdulla el Guhani.

The other great division of the Sudan Arabs, even larger and more loosely knit than the Guhayna, is the Ga'aliin, the members of which claim to be descended from 'Abbas, the uncle of the Prophet. In the main this group is sedentary; the Arab element *sensu stricto* that went to form it seems to have coalesced with the older settled inhabitants of Nubia and to a considerable extent to have adopted their social habits. Indeed, Mr. MacMichael applies the term Ga'aliin-Danagla to this, the other great moiety of Sudan Arabs, which includes most of the riverain tribes as well as a number of sedentary tribes in Kordofan.

It must be understood that the reviewer has been able to touch on some only of the outstanding features of this remarkable book, which, while holding so much detailed information, abounds in suggestions which will make it a source of inspiration to every worker in the field of which it treats.

A word of tribute should be paid to the Sudan Government for its enlightened policy in guaranteeing the amount necessary to permit publication.

C. G. Seligman.

The Utilisation of Coal.

The University of Sheffield: Department of Fuel Technology. Coal: a Series of Lectures on Coal and its Utilisation. By H. Chamberlain, J. W. Cobb, R. Lessing, F. S. Sinnatt, and M. C. Stopes. Pp. iii + 41. (London: The *Colliery Guardian* Co., Ltd., 1922.) 5s.

THIS publication in book form of the series of lectures on coal and its utilisation, delivered recently under the auspices of the Department of Fuel Technology of the University of Sheffield, renders the lectures available to a larger audience than that to which they were originally addressed. Each one is the work of an authority of acknowledged eminence in the particular branch of the subject treated, and, while of course containing nothing absolutely new, presents a clear and accurate picture of the present state of our knowledge brought thoroughly up-to-date. Perhaps the chief cause for regret is that the head of the Department of Fuel Technology, Prof. Wheeler, did not himself contribute to this series of lectures.

The first lecture, by Dr. Marie Stopes, deals with the subject which she has made peculiarly her own—the constitution of coal and the identification of the four constituents which she has isolated. This classical piece of work, at first merely of scientific interest, is gradually assuming an aspect of economic importance owing to the widely different properties of the various constituents. Wheeler and Lessing have shown, for example, that the coking property of coal appears to pertain almost wholly to the clarain and vitrain, fusain being quite and durain almost completely non-coking. At the same time, other researches would indicate that methods of separating these constituents on a commercial scale are at any rate possible of attainment, a measure of success having already been achieved in this direction by means of froth flotation. It is obvious that such a process may present great industrial possibilities and that it should be capable of greatly increasing the available supplies of coal suitable for the production of good metallurgical coke. Dr. Marie Stopes has not herself discussed this aspect of the question, although it is referred to in some of the later lectures; it may, however, be admitted that it is scarcely ripe yet for anything more than the passing reference which it here receives.

It is probably not the fault of Mr. F. S. Sinnatt, who deals with the preparation of coal for the market, that his subject is so wide that it is impossible to do anything like justice to it in so short a space; hence the lecture is necessarily of a sketchy character, and gives but little indication of the more modern developments of this important branch of technology. Mr. Sinnatt devotes a paragraph to the method of froth flotation, but does not attempt any discussion of the theoretical principles upon which this process is based; indeed, throughout his lecture he omits any explanation of the scientific principles upon which the various processes depend, though undoubtedly such discussions would have added very much to the value of his contribution.

The third lecture, by Dr. R. Lessing, is on the carbonisation of coal. The four main products of the decomposition of coal—the solid, the viscous, the liquid, and the gaseous—are dealt with, and the importance of each is pointed out, and the effect upon it of the different methods of conducting carbonisation. Dr. Lessing gives a full account of his own method of carrying out laboratory coking tests and indicates their practical application; at the same time he shows clearly the difficulties of following in detail the course of the coking operation on a large scale owing to its great complexity and to the number of varied changes that are taking place simultaneously. This is a very wide subject and one of very great importance; it may be noted that almost simultaneously with the appearance of the work under review, the Society of Chemical Industry has published an important paper by Sir George Beilby on the structure of coke, its origin and development, which is wholly devoted to the minute study of a detail which Dr. Lessing is perforce compelled to dismiss in a few lines. Dr. Lessing's lecture concludes with a review of the three types of industrial carbonisation, in gas works, in coke ovens, and in low temperature plant, although it may well be held that the term "industrial" is much too flattering a term to attach to the last-named process as it exists to-day.

In the fourth lecture Mr. Horace Chamberlain deals with the purification of coal gas from the gas-maker's point of view; his contribution is in every sense an admirable one, clear, concise, and yet setting out the principles of the various processes in sufficient detail. Perhaps the only cause for regret is that he has passed over the Burkheiser process for the utilisation of the sulphur in coal gas in somewhat too summary a fashion. It is true that this has not been a success up to the present, but it is by no means impossible that the process may contain the germs of a highly successful practice in the future.

The last lecture, by Prof. Cobb, is on ammonia from coal, in which the author shows clearly, as the result of much experimental work, the conditions under which the maximum production of ammonia may be obtained by the decomposition of coal; it need scarcely be said that the subject is one of the greatest importance, having regard both to the great manurial value of the product for agricultural purposes and to the highly important part that it plays in the economics of coal carbonisation. The lecture concludes with a brief review of the present position of the synthetic processes for the production of ammonia, the chief protagonists being the Haber and the Claude processes; Prof. Cobb evidently holds the view that there is likely to be but little to choose between the costs of production of ammonia from coal and by synthetic methods, and that it is to-day impossible to say on which side the advantage will ultimately rest.

While each of the lectures is a complete little monograph in itself, the subjects have been carefully selected, so that the book as a whole covers well a large portion of the field included under the comprehensive title of the Utilisation of Coal, a subject which is of the greatest national importance at the present moment. It has often been said that British coal has been too cheap in the past, and that we accordingly got accustomed to squandering recklessly our greatest national asset; such habits of extravagance, once acquired, are not easily got rid of, but works like the one before us have at least the great merit of indicating the right road to a much-needed improvement in this respect.

H. LOUIS.

Astrology of Comets.

Tychonis Brahe Dani: Opera Omnia. Edidit I. L. E. Dreyer. Tomus iv. Pp. 377-524. (Hauniae: Libraria Gyldendaliana, 1922.)

IN these pages Dr. Dreyer has given us an interesting collection of papers on comets, not hitherto accessible to the learned world. After the concluding page of the well-known "De Mundi Ætherei recentioribus Phaenomenis" we have a treatise of sixteen pages in German, now printed for the first time, on the comet of 1577. Next come nine pages in Latin on the comet of 1585, printed at Uraniborg in the "Diarium astrologicum et metheorologicum" of Elias Olai Cimber for 1586, and seven pages in the same language now first published on the same comet. These last two treatises are mainly astrological, as is no small part of the treatise on the comet of 1577.

The largest part of the present fasciculus is, however, occupied with a controversy on comets between Tycho Brahe and the Scottish physician John Craig. Tycho had sent Craig a copy of his printed but as yet unpublished work, "De Mundi . . ." and Craig had replied in certain letters which as Dr. Dreyer informs us were published by Noltenius in 1737. These drew from Tycho an "Apologetica Responsio," filling sixty pages of the present volume. The work was printed and a few copies were sent to friends. It was Tycho's intention to include it along with the whole controversy with Craig as a supplement to his "De Mundi . . .," but his representatives wisely decided to let the main treatise go forth by itself. No printed copy of the "Apologetica Responsio" has survived, and Dr. Dreyer has edited it from a MS. at Copenhagen. Craig replied to this work in a treatise entitled "Capnuraniae restinctio," of which Dr. Dreyer has been able to give us a fragment from a Vienna MS. The task of replying to this work was ultimately undertaken by Kepler, but abandoned by him on Tycho's death, though Kepler's unfinished reply has since been published in his collected works. Dr. Dreyer's notes on the whole volume, including the "De Mundi . . .," occupy the last thirty-two pages of the present publication.

Not the least instructive of these studies are the astrological treatises. It will be observed that with the exception of the paper written for his assistant, Tycho early abandoned the intention of publishing them. In an age when nearly all science was based on an experience not supported by carefully recorded experiments and observations, it was reasonable to give to the supposed truths of astrology the same respect that was shown to scientific teaching generally. Tycho's astrology is neither fanciful nor arbitrary, but professes to regard observation as the test of truth. Thus on p. 413 he refuses to decide on the limits of the clima of Saturn, because they rest on no sufficiently attested experience. On the other hand, he regards it as a settled fact that the comet which was seen in Aries in 1533 changed the religion in Britain and caused lasting discord. Whatever value Tycho may have attached to such speculations, he could not but feel that they were work of a very different class from the great astronomical edifice founded on his own observations of precision.

The controversy with Craig is not without its analogies. Craig held with Aristotle that objects in the ether were immutable, while objects in the elements might suffer change, and that temporary phenomena like comets must, therefore, be sublunar. Tycho Brahe held that from the relative slowness of their motion and the absence of perceptible parallax they must be more distant than the moon. The question is of the ever recurrent type where observations seem to conflict with a general principle which has hitherto known no exception.

Our Bookshelf.

An Inorganic Chemistry. By Prof. H. G. Denham. Pp. viii + 684. (London: E. Arnold and Co., 1922.) 12s. 6d. net.

PROF. DENHAM has written "An Inorganic Chemistry" for intermediate students. In this field at least half-a-dozen excellent text-books are already available; but, perhaps for commercial reasons, additional volumes of similar scope continue to be produced, and the process may be expected to continue until each leading publisher is able to offer a book of this type. Prof. Denham's book is well printed and nicely illustrated, and in this respect compares favourably with other competing volumes.

The author claims as a simplifying factor the introduction of the periodic classification of the elements in the middle (instead of at the end) of the chapters on the non-metals; but it is doubtful whether this policy will be followed by other authors, because it is obviously difficult to classify the elements when only two groups of them have been described. The policy of including a brief description of all the less common elements (except those of the "rare earths") is also of doubtful value, in view of the great difficulty which intermediate students find in becoming acquainted even with the common elements when they pass from the study of the non-metals to that of the metals. More important perhaps is the fact that while atomic weights are given at a very early stage, Avogadro's hypothesis and the molecular theory are postponed to Chapter IX., with the result that for nearly 100 pages hydrogen gas is represented as H and oxygen gas as O; in the meantime, subjects such as the theory of solutions and thermo-chemistry, and even valency and structural formulæ, are discussed on this very inadequate basis.

The author's attention may be directed to the incorrect statements which result from his undue simplification of crystal forms, which he classifies by means of planes of symmetry instead of by means of crystallographic axes. It would also be well if it were clearly stated that the vapour-pressure curves of the different forms of sulphur are purely fictitious, although they are presented in the same attractive form as the solubility diagrams, which are a pleasing feature of the book; it may be suggested that the omission of the small squares might be used to distinguish those diagrams which are mere sketches from those where accurate data are given.

T. M. L.

Happy India as it Might Be if Guided by Modern Science. By A. Lupton. Pp. 188. (London: G. Allen and Unwin, Ltd., 1922.) 6s. net.

MR. LUPTON in a single cold-weather tour through the Indian Empire has tried to solve a series of economic problems, which have long engaged the attention of administrators and men of science. He is impressed, as all thoughtful observers of Indian life must be, with the general poverty of the people, their exhaustion by malaria, and their inability to resist periodical scarcity. The soil is ineffectually cultivated by weak plough cattle, the produce is extremely low when compared with that of other more fortunate countries, and much of the scanty manure is used as fuel. Here is the chance of science. Why not have a chemical examination of the soils of each district to find out what constituents are lacking? Why not establish a fuel reserve in each village? Why not lay down at every peasant's door wood from the Himalayas or coal from Bengal? Why not use electricity to pump water from the wells? Why not fill every puddle and so abolish malaria?

These are admirable schemes, but unfortunately the Government does not possess the means of raising enormous loans, paying the interest, or maintaining a new army of officials, in the hope that some day it will be repaid for the cost of 7,000,000 tons of superphosphates which he proposes to import, even if such a demand did not upset agriculture all the world over. It is very well to say, spend a few millions as a beginning, but this would do little to improve the situation, and, as he admits, there is little use in giving ignorant people superphosphates if you do not at the same time supervise their use by a corpus of experts. Even to make a fuel reserve in a village means taking up arable land for this purpose, and the peasant does not like reserves because they shelter wild pig, monkeys, and green parrots, his greatest enemies.

Mr. Lupton honestly admits that the Government is not to be blamed because every Hindu marries and rears a family, resulting in congestion of the population. He hopes vaguely that public opinion will check this abuse, but he admits that the educated Indian gentleman knows or cares little about the peasantry, and that "if the Indians govern themselves, we may be sure that their government will be bad." Mr. Lupton is to be commended for his good intentions, his fine sense of humanity, but it needs practical wisdom to consider the problems which he has attempted to solve.

The West Riding of Yorkshire. By Bernard Hobson. Pp. xii + 188. (Cambridge: At the University Press, 1921.) 3s. 6d. net.

MR. BERNARD HOBSON had a difficult task to describe the West Riding of Yorkshire owing to the wealth of the material. The term "Riding" means one-third, so that the area dealt with is only one-third of the county of Yorkshire; but as it includes the densely populated coalfield to the south and the limestone moors to the north-west, it contains areas of special importance and interest. Mr. Hobson has not only compiled an instructive summary of the geography, geology, and history of the West Riding, but has also presented it in a form interesting throughout. The most important geographical feature of the area is the Pennine Range, forming its western highlands, which is unique in England from the extent of its subterranean river system. The industrial districts include many important cities; the author's account of Sheffield is of especial interest. The history of man in the area dates from Neolithic times, for Mr. Hobson tells us that no undoubted trace of Palæolithic man has yet been found, though abundant remains occur only three miles from the Yorkshire border. The area is especially rich in archæological and historical monuments. In the chapter on the architecture it is remarked that the professional architect arose in the period of James I., before which building had been in the hands of the builder and the craftsman. Apparently, therefore, the end of the great age of building in England synchronises with the rise of the professional architect.

A Laboratory Handbook of Bio-Chemistry. By P. C. Raiment and G. L. Peskett. Pp. 102. (London: E. Arnold and Co., 1922.) 5*s.* net.

The book before us would be more appropriately entitled physiological than bio-chemistry, as in its scope it is almost entirely limited to the elementary physiological chemistry usually taught to medical students. A short theoretical account of each subject precedes the practical work. Much of this is quite sound, but the text is frequently marred by looseness or inaccuracy of statement, which requires stringent revision before the book is placed in the hands of a student. Examples of this will be found in the account of the action of acids on soaps (p. 45), the precipitation of globulins (p. 24), the properties of the albumins (p. 16), and elsewhere. Again, histidine is omitted from the list of amino-acids derived from proteins, vitamin B is stated to be associated with the fatty radicles of milk, and so on.

The practical work is almost entirely confined to qualitative test-tube experiments, the chief exceptions being the quantitative methods of urine analysis, and, in an appendix, Kjeldahl's method and the methods for estimating reducing sugars. These experiments are clearly described and easy to perform.

We do not, however, believe that practical biochemistry can be satisfactorily taught in this way. Preparative work and, especially, quantitative methods are essential even in the earliest stages. Unless this kind of exercise is freely introduced the student will acquire no real grip of the subject, but will regard it simply as another dreary course of "test-tubing."

A. H.

Meteorological Office: Air Ministry. British Rainfall, 1921. The sixty-first annual volume of the British Rainfall Organisation. Report on the distribution of rain in space and time over the British Isles during the year 1921, as recorded by more than 5000 observers in Great Britain and Ireland. Pp. xxiv + 300. (London: H. M. Stationery Office, 1922.) 12*s.* 6*d.* net.

Rainfall statistics over the British Isles have now been collected and published annually for a sufficient period to render the observations of very great value, thanks to the foresight and persistent perseverance of the late Mr. G. J. Symons. Where observations do not exist, a shrewd approximation of the average fall can be obtained by means of neighbouring measurements.

The essential feature of the volume is a discussion of the drought in 1921, which was more remarkable for persistence than for intensity over short periods, although June and July were probably drier than any two consecutive months in living memory. In England and Wales 1921 was probably the driest year since 1788, and in London it was the driest for at least 148 years. The south-east of England experienced the greatest severity of the drought, and a part of Kent had for the year less than 50 per cent. of the average rainfall. A coloured map opposite to page 150 shows graphically for the British Isles the relation of rainfall in 1921 to the average of 1881–1915.

Rainfall is discussed in connexion with scarlet fever, and there is an article at the end of the volume on the fluctuations of annual rainfall.

C. H.

Design in Modern Industry: The Year-Book of the Design and Industries Association, 1922. With an Introduction by C. H. Collins Baker. Pp. 157. (London: Benn Bros., Ltd., 1922.) 15*s.* net.

The Design and Industries Association, of which this appears to be the first Year-Book, is concerned with liaison work between the artist, the manufacturer, and the distributor, and aims at the improvement of British design through the intelligent and liberal use of the artist, both for ideal reasons and to meet foreign competition. The Association holds that good design is tested first and chiefly by fitness, and secondly by pleasantness in use. A teapot, for example, should have a spout that does not drip, a handle and spout that do not project unnecessarily (to save room in the cupboard and reduce risk of fracture), the lid should be securely held while the pot is in use, there should be the fewest, if any at all are necessary, of crevices and sharp angles, as these hold dirt and are difficult to clean, the cost should be reasonable, and so on. The illustrations include furniture, pottery, fabrics, kitchen equipment, metal work, printing, signs, tablets, shop fronts, etc. The designs as a rule are distinctly pleasing, and are appreciated by critical artists. The photographic reproductions are, with few exceptions, excellently done, but we hope that the Association in its second Year-Book will be able to introduce colour reproductions where they appear to be essential.

Alcohol in Commerce and Industry. By C. Simmonds. (Pitman's Common Commodities and Industries.) Pp. xii + 119. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 3*s.* net.

The late Mr. Simmonds had produced a larger and more detailed treatise on alcohol before undertaking the present small volume. It would therefore be anticipated that his treatment of the subject would be most expert. The present volume, in fact, is a wonderfully concise and complete account of the manufacture and uses of alcohol, and is well illustrated. It is perhaps scarcely realised by those not familiar with recent progress in chemical industry and engineering how many uses are found for alcohol, and how many more promise to be discovered. Mr. Simmonds's book will supply this information to the general reader, and the chemist will also find much that is useful in it.

Mathematics for Engineers. By W. N. Rose. (The Directly-Useful Technical Series.) Part I., including Elementary and Higher Algebra, Mensuration and Graphs, and Plane Trigonometry. Pp. xiv + 514. (London: Chapman and Hall, Ltd., 1922.) 10*s.* 6*d.* net.

The first edition of this work appeared in 1918, and was reviewed in our columns (Nature, vol. 101, p. 463). It has now been put to the test alike by teachers and students, and has proved its value. The third edition, now before us, has been thoroughly revised; there are few additions, but we note one on elementary determinants which contains enough to enable the reader to understand certain methods employed in works on aerodynamics.

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.*]

On the New Element Hafnium.

IN a former letter to NATURE (January 20, p. 79) we announced the discovery of a new element with atomic number 72, for which the name hafnium was proposed. Evidence was given that this element is a homologue of zirconium in accordance with theoretical expectations (Bohr, "Theory of Spectra and Atomic Constitution," p. 114, Camb. Univ. Press, 1922). Continued experiments enable us to complete the statements in the former letter. By the addition of a known quantity of tantalum (73) to our samples, and by a comparison of the intensity of the Ta-lines with the Hf-lines, a closer estimate of the amount of hafnium present has been obtained. We have investigated a great number of zirconium minerals from different parts of the world. They all contained between 5-10 per cent. of hafnium. In samples of commercial zirconium oxide investigated, we have found the new element, amounting in one case to as much as 5 per cent. Starting from the latter substance, by means of a chemical method which is also adapted to separate zirconium from the other tetravalent elements, we have been able to obtain several grams of a preparation in which the presence of about 50 per cent. of hafnium could be established. Conversely, we have succeeded in preparing zirconium in which no hafnium lines could be observed. Further particulars about the method of preparation and provisional determination of the atomic weight will be published shortly in the communications of the Copenhagen Academy.

D. COSTER.
G. HEVESY.
Universitetets Institut for teoretisk Fysik,
Copenhagen, January 31.

The Latent Period in Lubrication.

SOMETIMES in a scientific inquiry results accrue which are called, in laboratory slang, "pretty"; the pieces of the puzzle have fallen together in a fashion so pat as to give artistic pleasure.

Most lubricated surfaces have the curious property that the friction falls after the lubricant has been applied, until a steady state is reached after an interval which may vary from a few minutes to a few hours. For example, a clean surface of glass lubricated with pure heptoic acid, the slider being in position, the initial value of the coefficient of friction at 12° was $\mu=0{\cdot}51$, but in 40 minutes it had fallen to its steady value, $\mu=0{\cdot}40$.

This latent period, as it may be called, is shortened by a rise in temperature and, apparently, by mechanical agitation; and is manifested by surfaces lubricated only by a film of insensible thickness as well as by those flooded with liquid.

The most striking fact, however, is the influence of the slider. The final steady state is never reached unless the slider is in position. Surfaces which have been freely exposed to vapour or to an excess of fluid resting on them always have high friction when first put in contact. The lowest value is given only by a film of lubricant which has been enclosed for some time between two solid faces. Such is the puzzle, and the explanation is curiously simple.

A molecule of an aliphatic acid or alcohol is like a rod loaded at one end. Putting a drop of one of these substances on a clean surface is like flinging a handful of such rods, picked up at random, at it; some hit and stick by the loaded ends, others by the unloaded ends. Condensation from the vapour is similar except that the rods are flung singly.

It is practically certain that friction is lowest when all the rods are orientated in the same way, a condition which will be reached only when the wrongly orientated molecules have had time to evaporate off into the fluid or vapour and have been replaced by molecules rightly orientated. The latent period is the time occupied by this readjustment.

So long, however, as the layer is exposed to fluid or vapour it is always losing or gaining molecules by evaporation and condensation, and some of those arriving will be wrongly orientated. The layer will reach a steady state, but it will not be that of least friction because at any moment a fraction of the molecules will be wrongly orientated. Orientation will be as perfect as possible and friction at its lowest only after a layer has been for some time shielded from evaporation by being enclosed between solid faces.

If this explanation be correct there should be no latent period when both ends of the rods are alike. This is so. In normal paraffins both ends are alike, *and in no circumstances do surfaces lubricated by normal paraffins show a latent period.*

The fact that a latent period exists is of importance to practical lubrication. The molecular process which causes it is, we believe, of importance in the mechanics of living matter. Physiologists will note how it recalls du Bois Reymond's theory of muscle and nerve.

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January 23.

The Rule of Priority in Nomenclature.

IN NATURE for February 3, p. 148, Mr. F. Chapman mentions three distinct proceedings that may affect the stability of nomenclature in zoology. Concerning those that arise from differences of opinion as to the classificatory value of certain shapes or structures, or those that depend on the advance of knowledge, on corrections of fact, or on the need for breaking up unwieldy groups, it is useless to argue. No system of classification and nomenclature devised by man can cope with such inevitable changes.

The third proceeding, with which alone I venture to deal here, is the discovery that a name in general use was predated by a name that hitherto has been left in obscurity, and the consequent enforcement of the law of priority. On this point Mr. Chapman's letter overflows with good sense; but it has all been said before. His laments, however, will not have been entirely wasted if you will permit this consolatory reply—namely, that in the year 1913, at the International Congress of Zoologists in Monaco, an agreement was reached in the largely attended section on nomenclature and confirmed in plenary session, by which the International Commission on Zoological Nomenclature was given power, on certain conditions, to suspend the rules in those cases where their operation was contrary to the general convenience. The Commission has, on the request of various zoologists, already taken action in several cases. It has, for example, recommended, but not yet passed, the suspension of the rules in the case of Holothuria *versus* Physalia (Opinion 76), and is at the moment preparing to adjudicate on the name of the common house-fly (see NATURE, January 27, p. 115).

The Commission has also—urged thereto by its devoted secretary, Dr. C. W. Stiles—attempted to draw up for various groups lists of agreed and unalterable names, *Nomina conservanda*.

If, owing to the war and the peace, so thorough a worker as Mr. Chapman can have, apparently, forgotten or remained ignorant of the Commission's work, there must be many in the rising generation to whom it is equally unknown. If they cannot find what they want in the Report of the International Congress of Zoologists or, more accessibly, in the American periodical *Science* and in the Smithsonian "Miscellaneous Collections," they may like to know that the present members of the Commission in this country are Dr. Hartert and Dr. Jordan of Tring Museum, Dr. W. E. Hoyle of the Welsh National Museum, and myself at the Natural History Museum; also that the Commission is seeking to fill one of its vacancies with an Australasian representative.

F. A. BATHER.

The Formation of Coloured Bows and Glories.

WHEN favourably situated, a person may see rings of coloured light round the shadow of his own head, as cast upon a neighbouring fog-bank or cloud. These coloured rings or glories, as they are called, have been explained by previous writers as merely coronas due to particles near the surface of the cloud scattering light reflected from deeper portions of the cloud; in other words, the effect is regarded as of the same nature as the ordinary corona but due to secondary scattering. That this explanation cannot be accepted as correct is definitely shown by experimental observations made with artificial clouds.

The experimental arrangement is the same as that used by Mecke (*Ann. der Phys.*, vol. 61), and if the eye of the observer be placed on the same side of the cloud chamber as the source, so as to look down very nearly along the path of the beam passing through it, a succession of colours is seen along its track through the cloud. These colours also change as the angle of observation is changed; and the smaller the particle the greater is the angle from which they can be seen. The complete system of rings is obtained on illuminating the cloud with a beam of sunlight, and may be viewed in a perpendicular direction with the aid of a plane sheet of glass held at 45° in front of the cloud chamber, so that the observer's head does not screen the cloud chamber from the illuminating pencil. The observations prove that the phenomenon under discussion is shown by every position of the cloud, and therefore really arises from *primary* scattering by the droplets of water.

That the glories or brocken-bows arise in a way which is quite different from that of the ordinary transmission coronas is proved by the fact that the sequence of colours in the brocken-bows and in the transmission coronas due to cloud particles of the same size are far from being identical. The normal corona, due to larger drops, shows a central white field with a brownish-red edge, which is surrounded by the familiar coloured rings, but in the brocken-bows the arrangement is different and varies somewhat with the size of the drop. It is sometimes found that just round the central spot (which is the image of the source of light reflected from the first surface of the observing flask) there is a distinct minimum of intensity exhibiting colour; then the intensity increases, the colour being greenish-white bordered by a brownish-red edge, and then follows the usual succession of coloured rings as in the coronas. It is sometimes found that round the central spot there is a clear maximum, and then a belt of minimum intensity, and then again a maximum; in other words, there is an oscillatory distribution of intensity; in the central field of the brocken-bow only red and green rings or belts are present in different intensities, whitish-yellow colour being totally absent, while in the corresponding coronal rings the central field is yellowish-white or nearly without colour.

In order to understand how the glories are formed, we have to consider the light which travels back towards the source from the droplets. This arises in two ways: (*a*) by reflection from the front surface of the droplets; (*b*) by two refractions and one internal reflection. When a plane wave falls on the spherical particles and is reflected back at its external surface, the reflected wave front is strongly divergent, and, as a result, it merely adds a little to the general illumination of the field and does not give rise to any notable diffraction effect. But the wave front (*b*) formed by internal reflection is not so divergent as in (*a*), and is limited by a cusped edge, at which it is doubled back. When the droplet is small the path differences between back and front of the wave near the cusped edge are very small. Hence we may, without appreciable error, consider the wave front to be a simple spherical cap of appropriate radius. As a sufficient approximation, we may assume the centre of this spherical cap to be the image of a point placed on the axis at an infinite distance, produced by two refractions and one reflection. We have to find in directions making a small angle with the axis back towards the direction of the primary source the aggregate effect of this wave cap. The problem now is the same as the diffraction produced by a small circular opening in the screen on which light is propagated in spherical waves from a point source. We take as the axis of symmetry the line drawn from the source to the centre of the opening, and it is required to find the intensity of illumination at *any point* of a plane screen parallel to the plane of the opening and at a distance from the later. The detailed mathematical treatment of this problem is given in Gray and Mathews's "Treatise on Bessel Functions and their Applications to Physics," chapter xiv., and the result is applied in this case for the measurements of the positions of the maximum and minimum in the glory-rings. Considering the experimental difficulties and assumption in the theory, the results agree fairly well with the observations.

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December 13.

The Definition of Limiting Equality.

IN teaching the calculus to students of applied mathematics and physics I have found that the definitions of *limiting value* and of *limiting equality* given in practically all our text-books are unsatisfactory, and in my opinion inadequate. According to these books the test of limiting equality of two magnitudes is that their difference shall become less than any assignable *quantity*, however small. But this condition is satisfied by any two quantities whatever if they vanish simultaneously, and it affords no justification for the use of statements such as $dy = f'(x)dx$; on the other hand, if the quantities remain finite in the limit the test appears scarcely to be necessary or useful in teaching elementary classes.

I consider that the proper test of limiting equality is that the difference between two quantities should become (numerically) less than any assignable *fraction of one of the quantities*, however small, in other words that $x - a < ae$ where e is any *fraction of unity*, however small (instead of $x - a < e$ where e is any *quantity*, however small), *the present definition being assumed to hold good even if the two quantities vanish or become infinite at the limit.*

If this condition be accepted as the definition of limiting equality, the same condition will hold good for any multiples or submultiples, however large or small, of quantities which tend to limiting equality, and also to sums of such quantities; thus if $x_1 - a_1 < a_1e$, $x_2 - a_2 < a_2e$, etc., then $\Sigma x - \Sigma a < e\Sigma a$ under all conditions. Such statements as $dy = f'(x)dx$ are to be interpreted as statements of limiting equality according to this definition, and we arrive at a definition of an integral as the limit of a sum of products, which is applicable not only to integrals of functions of a single variable, but also to integrals taken over areas, volumes, and indeed any of the *concrete magnitudes* which commonly occur in problems on mechanics and physics. Roughly speaking, this definition may be worded somewhat as follows:

Let x be any magnitude which can be divided into elements Δx, however small, y a measure associated with it such that if y_1 and y_2 are the greatest and least values of y associated with any element Δx, y_1 and y_2 tend to limiting equality when the magnitude Δx diminishes indefinitely. Then, since $(y_2\Delta x - y_1\Delta x)/y_1\Delta x = (y_2 - y_1)/y_1$, the products $y_2\Delta x$ and $y_1\Delta x$ also tend to limiting equality, and by the theorem for the limit of a sum, the sums of the products $y_2\Delta x$ and $y_1\Delta x$ taken over all the elements also tend to limiting equality and their common limit is defined as the integral $\int ydx$. Any single product can be legitimately designated by ydx in any equation, provided that this equation is interpreted as a statement of limiting equality in accordance with the above definition. A subsequent proof is required to cover cases of discontinuity such as occur, *e.g.* when finding the volume integral of a function which changes by a finite amount in crossing a surface.

In defining a differential coefficient and proving the formula for the differentiation of a product, I follow Fricke's method to a great extent. Fricke, however, defines $f'(x)$ by putting $x_1 \to x$ in $\{f(x_1) - f(x)\} \div (x_1 - x)$, but I consider it preferable to consider the more general fraction $\{f(x_2) - f(x_1)\} \div (x_2 - x_1)$. If this fraction tends to a unique limit when x_1 and x_2 approach a common limit x by any process whatever, this limit is defined as the differential coefficient of $f(x)$. This condition covers the cases where either x_1 or x_2 is first put equal to x and the other variable becomes equal to x subsequently.

G. H. BRYAN.

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Museums.

THE article in NATURE of December 9 on "A Suggested Royal Commission on Museums" leads me to offer a few comments, based on recent experiences. It is trite to say that all museums are understaffed, but it may be worth while to point out some of the consequences of this condition. Being a student of wild bees (Apoidea), I have long been interested in the available collections of these insects. In 1920–21, I made a catalogue of all the species of bees in the British Museum, and also listed those at Oxford and Cambridge. Returning to America I catalogued the bees in the U.S. National Museum and the American Museum of Natural History. One of my principal objects was to bring about exchanges between these institutions, so I noted in most cases the size of the series. The authorities everywhere were extremely cordial to the exchange idea, and it was evident that if each museum would distribute its duplicates, which were often actually in the way, all would be greatly enriched, to the advantage of students on both sides of the Atlantic. Up to the present, it has been impossible to carry out the proposed plans, because the curators have been fully occupied in other ways. The prospects will necessarily remain unfavourable, so long as each man has many more duties than he can attend to. The staffs should be increased, and should include at least two types of men—those who are principally concerned with research and those who are primarily curators. The latter type, with a passion for collecting and arrangement, is not to be found everywhere, and is not produced by the universities. It involves, however, a high grade of ability, and should be zealously sought by heads of museums.

In their zeal for economy, many will object to increasing museum staffs. They ought to consider the matter as they would a factory or other commercial plant. A great deal of capital, material and otherwise, has been put into our museums. With a moderate increase of funds they can be made to function far more efficiently and develop more rapidly. The public policy has too generally been like that of a man who had built a house, and decided that he could not afford a roof. In some cases sheer poverty may afford an excuse, but even the United States, with all its wealth, treats its National Museum in the most niggardly manner. The truth is, that in a democracy the public will is the driving force, and an ignorant public has no will. It is the duty of scientific men to carry on a campaign of publicity, which need not involve anything detrimental to their self-respect.

One reform which I should much like to see at the British Museum (Natural History) is the establishment of a room of British entomology, with a special curator who made it his business to know the species of the country. As things are at present, the average collector is interested primarily in British species, but on going down to the Insect Room he has to appeal for help to a world-specialist in some group, who is perhaps monographing a particular family of beetles. Any one with a conscience hates to take much of the time of such a man for his relatively insignificant matters, and the specialist himself probably does not know the British Staphylinidæ or weevils. By assembling the British series in one room, in charge of a special man, or preferably two or three, the work of the amateur would be greatly facilitated, and young naturalists would not be blighted in the bud by a sense of the trifling character of their pursuits. This is not a criticism of the existing curators, whose courtesy and good nature under stress have often caused me to marvel.

Just to show the spirit of the place, I will relate a couple of amusing instances, which I myself witnessed. A man came to the department of insects with an account of a proposed patent for catching fleas by entangling their feet in the supposed perforations in diatoms. The nature of the markings on the siliceous framework of diatoms, and their relative size to the feet of a flea, were explained in all gravity and kindness, and presumably the new flea-powder never appeared on the market! Another day, a man came to the department of geology with a clay model of an ox or some such animal, and I shall never forget the courteous way in which an eminent palæontologist assured him that the specimen should really go to the Museum at Bloomsbury, since a fossil would show only the bones, and not solidified flesh. The public certainly gets all it pays for, and more; but it could be much better served if it would pay enough to bring out the latent possibilities of the museum, which are doubtless greater than any of us can yet clearly imagine. T. D. A. COCKERELL.

University of Colorado.

Spiranthes Autumnalis.

IN the summer holiday of 1921, Mr. Mayland and I were astonished to find in the woods round Carrbridge, Inverness-shire, very sporadically but at two stations about a mile apart, specimens of the small orchid, *Spiranthes autumnalis.* We took some, and for two or three days their characteristic scent and spiral spikes interested our table in the hotel. I regret now that we did not preserve specimens: but I am pretty sure we were not mistaking the identity of the plant, as it was repeatedly the subject of remark, and I have known it since I was a boy.

I mention this non-recorded record because Sir Herbert Maxwell, who in September 1920 wrote to NATURE (vol. 106, p. 79), telling of a similar experience on Lower Spey-side; but in a later letter (vol. 106 p. 409), he expressed some uncertainty as to the identity of his plant as apart from *Goodyera repens.* Now when so acute an observer as Sir Herbert has arrived independently at the same conclusion as we did, I think the probability is strong that both diagnoses were correct, and that, though the specimens were not preserved as evidence, *S. autumnalis* has been found in an unexpected, non-calciferous locality.

Mr. Mayland tells me he sought it again in the following summer without result. F. O. BOWER.

The University, Glasgow, January 17.

The Scattering of X-Rays in Liquids.

IN various notes published last year I dealt with the scattering of light in transparent media, and showed that its study initiated by the late Lord Rayleigh in his theory of the colour of the sky has other fascinating applications in the explanation of the colour of the sea and other transparent waters, and of the colour of ice on glaciers. The thermodynamic theory of "fluctuations" developed by Smoluchowski and Einstein formed the starting-point in the discussions, but I was careful to emphasise the important complications arising from the anisotrophy of the molecules in fluid media and showed how the necessary corrections in Einstein's theory may be made. A considerable measure of success was attained in attempting to correlate the behaviour of substances in the liquid and gaseous states in this respect, and in predicting the effects due to alterations of temperature and pressure. The study of the changes in the intensity and states of polarisation of the scattered light in passing from the liquid to the solid crystalline state and their explanation forms another important line of inquiry in which some progress has also been made.

The purpose of the present note is to point out the relation between the optical effects referred to above and the very interesting recent work of Keesom and Smedt, who have obtained Laue photographs of various liquids traversed by a *homogeneous* pencil of X-rays (Proc. Roy. Soc. Amsterdam, 1922, page 119), and the similar work by Hewlett (*Physical Review*, December 1922, page 702), who used the ionisation method. Keesom and Smedt found that many of the liquids studied gave a well-marked diffraction ring at a considerable angle with the direct pencil. With liquid oxygen and argon, the first ring was formed at an angle of 27°. A weak second ring was also observed at 46° with oxygen, and at 49° with argon. With water, on the other hand, the second ring was very broad and diffuse and practically abutted on the first.

Keesom and Smedt have attempted to explain their results by various special assumptions regarding the relative positions of the neighbouring molecules, while Hewlett suggests that liquids possess something of a crystal structure. To the present writer it appears that the experimental results may be explained without any such special assumptions. As in the optical case, the liquid molecules may be regarded as the diffracting centres which are arbitrarily orientated and distributed uniformly in space subject only to such variations as give rise to density fluctuations in accordance with the Einstein-Smoluchowski formula,

$$(\Delta\rho)^2 = \frac{RT\beta}{V} \cdot \rho_0^2$$

where ρ_0 is the mean density $(\Delta\rho)^2$ the mean square of its fluctuations, R the gas constant, T the absolute temperature, β the compressibility of the liquid, and V the elementary volume under consideration. When traversed by a homogeneous pencil of X-rays the wave length of which is smaller than the average molecular distance, such a structure must give rise to diffraction rings which are more or less well defined according as the fluctuations of density are small or large. If in the expression for the density fluctuation, we take V to be a small cube with a molecule at each of its corners, the average fluctuation in its size and the resulting weakening of the diffraction pattern can be calculated somewhat on the same lines as in Debye's theory of thermal effect in X-ray reflection by crystals. In Keesom and Smedt's experiments, the low temperature in the case of liquid oxygen and argon, and the consequently diminished fluctuations of density must have helped in improving the definition of the diffraction ring of the second order. C. V. RAMAN.

"Artificial" Vertical Beam.

THE vertical beam through a low sun is generally referred to the reflection of sunlight from the basal surfaces of thin plates of ice which are falling through the atmosphere with their crystal axes vertical and horizontal. It has been the writer's good fortune to examine such reflections from individual "plates" that were slowly falling within a metre or so of the observer. Most of the plates were asymmetric portions of flat crystal growths, and they spun rapidly as they fell, with a motion resembling that of a falling maple-key. In this case, the vertical beam was observed to spread out slightly as it receded from the sun, and the angle subtended by the edges of the beam was obviously the complement of the vertical angle of the "cone" swept out by the rapidly rotating, but slowly falling flake.

An interesting "artificial" example of (probably) this phenomenon, was noted by many observers at the burning of two buildings at the Sydenham Military Hospital at Kingston, Ontario, on the night of January 3, 1923. The structures burned fiercely in the brisk north-east wind and lit up the snow-covered country for miles around. The unusual brightness may be judged from the credible report that people more than a mile from the fire easily read newsprint by its light. A very light snow-fall was barely noticeable from time to time during the evening. Out of the glow of the fire-lit smoke clouds there appeared to rise a vertical parallel beam of light, that with varying distinctness was visible for the three or four hours during which the fire raged. It was visible from points near the fire—a few hundred yards—but was more striking from points a quarter to a half a mile away, from which the flames themselves could not be seen. It seemed to vary with some atmospheric condition (more or fewer snow crystals in the air ?) as it might be dim when the diffuse reflection of fire-light from the low-lying clouds would be brightest, and might be sharp and bright during a lull in the flames. It was, however, often most striking when the conflagration was at its height.

It was not due to shadow of the still-standing walls—the light coming from the burning interior—for it was first noticed when the roof had just caught fire and most of the light came from the burning shingles—a case where no wall shadow was possible. Further, the beam was sensibly parallel-sided. A wall-shadow would have given a broadly diverging beam. The explanation offered is that of reflection from falling flat snow crystals, which, of course, were not over the burning building but were distributed in the atmosphere between the observer and the source of light.

The official record at the Queen's University station of the Canadian Meteorological Service, taken just before the fire broke out and less than a mile from Sydenham Hospital, gave "Temperature 12° Fht., Wind N.E. 20 miles per hour, Light Snow." In fact, the snow-fall was so light that the record of precipitation over the twelve hours, including the time of the observations on the beam, was only 0·03 inch.

WILL C. BAKER.

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January 8.

Unusual Crystals.

THE following may be of interest to readers of NATURE:

I have a bottle of pure phenol which has not been opened for a dozen years. During this period I have been interested to watch the growth of crystals from the sides of the empty portion of the bottle by sublimation. These crystals are cylinders or prisms many of them between two and three centimetres in length and as many millimetres in diameter. The ends are not pointed but neatly trimmed off by an oblique plane.

On closer examination these crystals prove to be thin walled tubes. The stalk attached to the bottle is solid for a few millimetres. Then a fine capillary appears, spreading out conically until the wall is about a half millimetre thick and then continuing as a uniform tube. The explanation is of course that within the tube the air is just saturated with phenol vapour while outside it is slightly supersaturated.

I do not remember meeting any published description of such crystals.

G. H. MARTYN.

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January 19.

Science and Armaments.

WHAT Dr. Martin regrets, in his letter to NATURE of January 20, p. 82, is to me a consolation—to know that scientific men in our universities are still working for the safety of the realm, for across the Channel there are fierce black clouds and ominous rumblings of strife that seem almost beyond control.

Dr. Martin says: "So may the temple of science be kept free from echoes of human quarrels," and instances the sojourn of Davy and Faraday in Paris. Is the example fortunate? Davy was irresistibly attracted to Paris by reports of a detonator of fearful violence that had already deprived Dulong—its discoverer—of an eye and a finger. He spent much of his time there investigating another discovery of a manufacturer of salpetre, a substance not unknown to Ministers of Munitions.

It was this very journey that occasioned the human quarrel that we seek to forget when contemplating the lives of these two great priests of the temple of science.

JAMES WEIR FRENCH.

Anniesland, Glasgow, January 22.

The Opacity of an Ionised Gas.

IN a paper read before a joint meeting of the American Physical Society and the American Astronomical Society, in December, I pointed out that theoretically the absorption of radiation by free electrons should render an ionised gas highly opaque. The organised vibrational energy, due to the radiation, of the free electrons is transformed by collisions into disorganised thermal energy of translation. A tentative application of the methods of the well-known free electron theory of the optical properties of metals to conditions in an ionised gas gives the following equation for the volume opacity coefficient K. The quantity K is such that in distance z centimetres through the gas the intensity of the direct beam is reduced to e^{-Kz} of its initial value.

$$K=(6\cdot 7\times 10^{26})\frac{\lambda^2 A^2 i p^2}{T^{7/2}(1+i)^2}.$$

Here λ is the wave-length of the radiation in centimetres; i is the ratio of the number of free electrons to the number of atoms and ions; p is the gas pressure in atmospheres, including the partial pressure $ip/(1+i)$ of the free electrons; T is the absolute temperature, Centigrade; and A is the radius in centimetres of an atom or ion (assumed equal in size—a very rough approximation). This type of opacity increases as the square of the gas pressure, while the opacity due to general scattering increases only as the first power of the pressure. Even at fairly low pressures, however, the effect of absorption predominates in an ionised gas.

The above equation follows from the following assumed equation of motion of a free electron in an ionised gas through which radiation is passing:

$$m\frac{du}{dt}+2rmu=eX,$$

where m is the mass, and e the charge of an electron, and u is its component velocity in the direction of the electric vector X of the radiation. The term $2rmu$ represents a pseudo-frictional resistance due to collisions between electrons and atoms or ions; r is the number of such collisions per second per electron. The usual assumption is made that the velocity of an electron after colliding with an atom is independent of its velocity before collision; and collisions between electrons are neglected. (When the scattering of radiation by free electrons is dealt with a term involving $-d^2u/dt^2$ is added to the left-hand member of the equation.) The average rate at which energy is absorbed from the radiation by each electron is the average value of $\int eXu\,dt$; and, remembering that the intensity I of the radiation is $cX_0^2/8\pi$, where X_0 is the amplitude of X, K is easily found. The number of collisions per second per electron is taken as $\pi NA^2\sqrt{3RT/m}$, where N is the number of atoms and ions per unit volume, and R is the gas constant per molecule. This relation assumes equipartition of energy between free electrons and the other molecules in the gas.

The well-known experimental work of Dr. Anderson at Mt. Wilson has shown that the opacity of the vapour of an exploded iron wire under certain conditions is such that light is cut off in a distance not greater than a few centimetres. Application of the above equation for K indicates that the absorption of radiant energy by the free electrons in the doubly ionised iron vapour produces an opacity of this order of magnitude. Thus, estimating T as 20,000 degrees absolute, i as 2, A as 5×10^{-8} cm. (doubtful), and $p/(1+i)$, the partial pressure of the iron ions, as 20 atmospheres (doubtful), K comes out as 1·7 for $\lambda = 6 \times 10^{-5}$ cm. The electrical conductivity of the vapour theoretically is 1/1500th that of metallic copper.

Application of the equation for K to conditions in the outer regions of the sun, employing Saha's theory to calculate the ionisation as a function of the unknown gas pressure, makes it seem probable that at a depth in the sun where the pressure is as great as 0·01 atmosphere the ionised gas is sufficiently opaque to cut off radiation from farther down. This is, then, indicated as the approximate pressure in the solar photosphere; and pressures in the solar atmosphere are much lower. Thus the sharpness of the Fraunhofer lines may be explained. I hope soon to publish these results in detail. The astrophysical importance of the matter is obvious.

Naturally it will require a great deal of study to develop more than a rough theory of the opacity of an ionised gas. Radiation is selectively scattered by bound electrons; it is non-selectively scattered by free electrons; and it is absorbed by free electrons. The part played by bound electrons in absorbing radiation (that is, in transforming it to heat) seems at present far from understood. Prof. Eddington's recent discussion (*Observatory*, December 1922) of the absorption of radiation by quanta in the deep interior of stars perhaps opens a new line of attack on the general problem.

JOHN Q. STEWART.

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January 8.

The High Temperature of the Upper Atmosphere as an Explanation of Zones of Audibility.

THE work of Lindemann and Dobson on the theory of meteors,[1] with the remarkable conclusion that the temperature of the atmosphere at heights such as 80 kilometres is about the same as that near the earth's surface, will be far-reaching in its influence. May I be allowed to point out that one of the phenomena for which an explanation will probably be provided is the occurrence of zones of audibility and zones of silence, surrounding the scenes of great explosions.

If, as Lindemann and Dobson find, temperature increases rather rapidly at about 60 kilometres, then sound waves penetrating that region will be refracted back to earth, the comparatively rapid curvature of the sound rays making the phenomenon almost equivalent to reflection as is the case with the light rays which occasion mirage.

If we assume a sharp transition of temperature from 220° A. to 280° A. we find a refractive index for sound rays passing from the lower level to the upper of $\sqrt{280/220}$ or 1·13. Total reflection takes place with an angle of incidence 62°, and if the reflection is at 60 kilometres the minimum radius for the outer zone of audibility is $2 \times 60 \times \tan 62°$ or 155 kilometres.

This rough estimate is of the right order of magnitude, as may be seen by comparison with the most recent example, the Oldbroek Explosion of October 28, 1922, for which the corresponding limit is stated to have been "about 180 or 200 km." (NATURE, January 6, p. 33).

There should be no great difficulty in adapting the theories worked out by von dem Borne and de Quervain to the new hypothesis. The drift of meteor trails shows that there is considerable horizontal motion of the atmosphere at such heights as 60 kilometres, and this motion will have to be taken into account. It is not unlikely that monsoonal changes in the upper winds produce the seasonal variation in the direction of audibility which was so noticeable during the war. The number of known observations of meteor trails is too small (*cf. Meteorological Magazine*, vol. 56, p. 292, 1921) to throw any light on this question.

Further progress in our knowledge of the temperature of the outer atmosphere and of its motion would be made if Prof. Goddard could send up his rockets. The times of passage of the sound waves from the bursting rockets would give immediate information as to the temperature of the air. Perhaps it would be more practicable to use a "Big Bertha" to send up a bursting shell. Mr. Denning could say, no doubt, whether there are any instances in which the disruption of a meteor has been heard and the time interval between sight and sound has been recorded.

With regard to the theory suggested by Lindemann and Dobson in explanation of the high temperature of the outer atmosphere, it should be pointed out that the atmosphere is only exposed to solar radiation during the day-time. It would seem that the equation by which the authors determine the steady temperature should be modified considerably. Annual variation in the temperature of these outer layers of the atmosphere is to be anticipated; it is not unlikely that examination of the statistics regarding meteors will reveal it. According to the theory meteors should reach much lower levels in winter than in summer.

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[1] A Theory of Meteors, and the Density and Temperature of the Outer Atmosphere to which it leads. F. A. Lindemann and G. M. B. Dobson (Royal Society Proceedings, vol. 102, 1922, p. 411).

Fixation of Nitrogen by Plants.

IN NATURE of January 20, p. 95, reference is made to an announcement in *Science* by Lipman and Taylor that they have proved conclusively the fixation of atmospheric nitrogen by the wheat plant. Should the detailed evidence, when available, show that their claim is well founded, it should not be forgotten that similar results on other plants were obtained in this country some little time ago by the late Prof. Benjamin Moore and his co-workers. In two communications to the Royal Society (Proc. Roy. Soc., B, vols. 91 and 92, 1920), he argues strongly in favour of such fixation, supporting his views by convincing experimental proof on both fresh-water and marine algæ. The work was incorporated in his book "Biochemistry" (1921), and in the Hugo Müller memorial lecture delivered before the Chemical Society in June of that year—one of his last public utterances—he reiterates in the strongest language his belief, founded upon no inconsiderable amount of experimental work, "that both the lower and higher plants do build up nitrites and nitrates and form organic nitrogenous compounds from the free nitrogen of the atmosphere."

I may say that in their article in *Science* Messrs. Lipman and Taylor give references to Moore's work as to that of other previous observers.

EDWARD WHITLEY.

Biochemical Department,
University of Oxford,
January 24.

Insulin, Diabetes, and Rewards for Discoveries.

By Sir W. M. Bayliss, F.R.S.

A NUMBER of problems, some of great scientific interest, others of practical importance in various ways, have been brought to notice by the somewhat sensational statements in the daily press relating to the Canadian treatment of diabetes by a preparation extracted from the pancreas and known as "insulin" (see Nature, November 25, p. 713; December 9, p. 774). In order to understand the state of affairs, it is necessary to review briefly our present knowledge of the physiological processes concerned with the utilisation of carbohydrate food. This will also serve to direct attention to gaps which need filling up, and the opportunities afforded by a trustworthy preparation of the hormone of the pancreatic "islets." If such a preparation shows itself to be of value in the treatment of diabetes in man, it is clear that difficulties of several kinds arise in the ensuring of an adequate commercial supply of an active product. We shall see further that the question of due rewards for discoveries which involve the cure of disease arises in the present case in an acute form.

If we look at tables drawn up to indicate a reasonable proportion between the constituents of a normal diet, we notice how large a part of the total energy required is supplied by carbohydrate. In that of the Royal Society Food Committee, for example, more than 65 per cent. is from this source. The justification is given by the fact that evidence of various kinds shows that the material from which muscle directly derives the energy for its activity in normal conditions is glucose. This is burned up with consumption of oxygen, while the products finally leave the body as carbon dioxide and water. Since measurements of the "Respiratory Quotient" in muscular work form a part of the evidence and are of importance in judging the properties of insulin, a word may be useful here as to the meaning of this number. If glucose is burned in the ordinary way in air, and the amount of oxygen consumed and of carbon dioxide and water produced is determined, the volume of carbon dioxide is found to be equal to that of the oxygen used. This is of course due to the fact that carbohydrate contains sufficient oxygen in its molecule to oxidise the hydrogen. Fat or protein, on the other hand, requires more oxygen, to burn part of the hydrogen as well as the carbon. The respiratory quotient expresses the ratio of the volume of the carbon dioxide produced to that of the oxygen consumed, so that if carbohydrate alone is burned, the value is unity, and it decreases in proportion to the amount of the fat or protein burned. If it rises, due attention being paid to absence of retention of carbon dioxide, we are justified in concluding that more carbohydrate is being oxidised.

Glucose is also known to be consumed in other organs—the secreting glands, for example—and probably in the tissues generally. It is supplied by the blood, although only present therein in very low concentration, about 0·1 to 0·15 per cent. Being a crystalloid and filtering through the glomeruli of the kidney, a large quantity would be lost were it not that as this filtrate flows along the renal tubules, the glucose is almost entirely reabsorbed, along with other constituents of value. If, however, the concentration of sugar in the blood rises above the normal value (hyperglycæmia), owing to a large amount of carbohydrate in the food, or an incapacity on the part of the tissues to consume it to the proper degree, then the absorptive power of the kidney is insufficient, and sugar appears in the urine (glycosuria). The glycosuria resulting from excess of blood-sugar owing to diet is in itself harmless; glucose is often added to gum-saline for intravenous injection in cases of traumatic shock. When glycosuria, on the other hand, is due to failure to consume glucose, we have the morbid state known as diabetes mellitus, in which there are involved other consequences of this defect, themselves giving rise to serious symptoms.

Since the supply of sugar from the digestive canal is intermittent and in excess of the immediate demand, while this demand is constant, it is clear that some means of storage is needed. This is provided by the liver, which deposits glucose in its cells in the form of the insoluble glycogen. From this store it is released as required. The muscular tissues, especially that of the heart, are also able to store glycogen to some extent. Now in diabetes it is found that the liver has lost this power, although the muscles retain it. It is not obvious why this loss of storage power in the liver should be connected with failure of the tissues generally to consume glucose, but so it is; and there is another rather remarkable fact. If the food given to a diabetic animal is devoid of carbohydrate, glucose is produced from certain amino-acid components of proteins, although it is not utilised, and escapes in the urine. It may be that the consumption of glucose is never completely absent in diabetes, but is dependent on a high concentration in the blood. This minimal consumption being absolutely essential to life, it is provided from protein, if no other supply is available. Hence the great wasting of body substance present in diabetes.

In the year 1889, a paper by Von Mering and Minkovski was published, in which it was shown that if the pancreas was removed from dogs, a condition like that of diabetes was produced. They found further that if a small piece of the pancreas had previously been grafted under the skin, removal of the rest of the pancreas was ineffective until this graft was also removed. It was also found that ligature of the ducts of the pancreas did not produce diabetes. These results pointed clearly to an internal secretion from the pancreas as being necessary for the utilisation of sugar. It was found that the residue of pancreatic tissue left in both the cases referred to consisted of the structures known as "Islets of Langerhans," and it was advocated by Sharpey Schafer that these organs are responsible for the internal secretion. Further evidence confirmed this view, although there are still some differences of opinion as to the independence of the islet tissue and the ordinary secreting tissues. The discovery of Diamare that in many teleostean fishes the islet tissue exists in organs separate from the pancreas is important evidence that this tissue is not in the adult formed from the pancreatic cells. In Lophius, according to Diamare, these masses of islet tissue may be as large as peas. But, for some reason or other, extracts of the pancreas have only occasionally been found to have any influence when given to diabetic animals. The active constituent is destroyed by some other substance, possibly trypsin, contained in such extracts.

Since the cells which produce trypsin degenerate after tying the ducts, it occurred to Dr. Banting, rather more than a year ago, that extracts of such organs might contain the active principle sought for, free from destruction. Dr. Banting was then in medical practice at London, Ontario, but gave up his practice and went to Prof. Macleod's laboratory at Toronto to make the necessary experiments on animals. Here he was joined by Mr. Best, an assistant in the laboratory, by Prof. Macleod himself, and at a later date by Dr. Collip and others. The experiments were successful. In another way it was found possible to prepare active extracts. It had been noticed that the presence of a fœtus protects the mother. The islet tissue, as it appears, begins to be functional at an earlier date than the secreting cells, so that by taking the pancreas of a fœtal calf at the appropriate age, the destructive agent was absent. But it was clear that these methods could only afford a small supply. Hence attempts were made to discover a means of preparation from the ordinary ox pancreas. Dr. Collip was finally successfully by making use of alcohol. The active principle, which it is proposed to call "insulin," is soluble in alcohol of a strength such as to precipitate enzymes, proteins, and probably other substances, although, like secretin, it is insoluble in absolute alcohol. This latter fact gives opportunity for further purification from lipoid. It is finally obtained in solution in physiological saline, suitable for subcutaneous injection. The absence of protein is necessary for clinical use, because of the possibility of anaphylactic shock, if the injections were omitted for a time and then resumed.

Passing next to the properties of insulin, it was found that if injected subcutaneously into animals made diabetic by removal of the pancreas, or indeed hyperglycæmic in any way, the sugar content of the blood was reduced and the glycosuria abolished. Moreover, a very interesting fact was discovered. The blood sugar can be reduced in normal animals by insulin, but if it falls below a certain level (about 0·045 per cent. in rabbits), nervous symptoms come on, and the animal may die in convulsions. These symptoms are at once removed by injection of glucose. Thus the normal activity of the central nervous system depends on the presence of a sufficient concentration of sugar in the blood. It is probable, therefore, that sugar is burned in the brain, and possibilities of investigating the energy value of the cerebral processes associated with mental activity open before us. The fact, however, causes a difficulty in the clinical use of insulin. If too large a dose be given, or it be absorbed too rapidly, nervous symptoms make their appearance. Fortunately, they are unmistakable by the patient, who can at once have recourse to the sugar basin.

Another important action of insulin is to reduce or abolish the presence of acetone and its derivatives in the blood and urine—a characteristic sign of the diabetic state. These compounds have a toxic action on the nervous system, finally leading to coma and death. They are the result of incomplete combustion of fat, and are present whenever insufficient sugar is being oxidised—in carbohydrate starvation as well as in diabetes. It is an interesting fact that neither fat nor protein can be properly utilised without carbohydrate. The oxidation of the former appears to be a kind of "coupled reaction" with that of sugar, and we therefore ask what is the common component? Pyruvic acid or aldehyde, as a stage in the oxidation of both, has been suggested. Vahlen put forward the view some years ago that the function of the pancreatic hormone was to convert glucose into a simpler compound more easily oxidised. These possibilities may be accessible to experiment *in vitro* by the use of concentrated solutions of insulin. According to some recent work by Winter and Smith in the Biochemical Laboratory at Cambridge, it seems that γ-glucose, the reactive ethylene-oxide form of glucose, is the first stage, insulin acting as the activator of some enzyme in the tissues. In the normal state, the blood sugar is in the γ-form, presumably not in diabetes.

The failure to make use of protein in the absence of concurrent oxidation of glucose may have some bearing on another characteristic of the diabetic state—the imperfect healing of wounds. It is pointed out by Dr. Formiguera in the *British Medical Journal* of December 9 last that insulin will be of much value in making possible the performance of necessary operations in the diabetic—a matter otherwise not to be done. Prof. Starling has suggested that its use may also make it feasible to transplant grafts of fœtal pancreas into such cases. Although the work of Leo Loeb has made it clear that tissues from another individual, unless a very closely related one, degenerate sooner or later when transplanted, embryonic tissues are not so extremely individualised, and the experiment is worth trial.

Insulin confers on the diabetic liver the power of storing glycogen.

Since the capacity of oxidising glucose is deficient in the diabetic animal, an injection of glucose does not raise the respiratory quotient; whereas if insulin be given at the same time this happens. Thus we have the proof that glucose is actually burned and not caused to disappear in some other way. It is further shown by Hepburn and Latchford that the excised heart of the rabbit consumes more glucose if insulin be added to the perfusing solution. Unfortunately, it was not shown that the respiratory quotient was raised, and the authors have overlooked the fact that Starling and Evans in 1914 found in some cases that the respiratory quotient of the diabetic heart was raised by the addition to the blood of an acid extract of the pancreas. It may be remarked that trypsin being inactive in acid solution, it was thought to avoid destruction of the hormone in this way. Indeed, although it is actually destroyed in an alkaline solution of trypsin, it is not certain whether it may not be oxidised, or destroyed by some agent other than trypsin itself.

Insulin, given to diabetic patients by subcutaneous injection, is found to have the same effects as in animals, together with an unmistakable improvement in condition. Apart from its relieving the serious symptoms actually present, it is greatly welcomed in place of the "starvation" treatment of Allen, the only other treatment of value. But it is evident from what has been said above that there is much to be found out in respect to its practical use. Since only a small dose can be given at one time, because of the nervous effects of too great a reduction of the blood sugar, and since the effect only lasts about twelve hours, it is clear that two subcutaneous injections per day are necessary. Although it may be said that people addicted to morphine or cocaine use the process as often as this, the difficulty is not to be overlooked. If the morbid condition of the pancreas has not advanced too far, it may turn out that insulin "relieves strain," as it were, so that the normal state may ultimately be restored. But this has not yet been ascertained. Destruction by the pancreatic juice makes insulin ineffective if taken by the mouth. Perhaps some method may be found by which it may be caused to be absorbed by the stomach before being destroyed. The supply on a large scale involves problems, moreover, which do not arise in the small scale operations of the laboratory.

Here we meet with the knotty question brought into prominence by the action of the University of Toronto in taking out a patent and offering the rights in this country to the Medical Research Council. According to the statement published by this body in the *Times* of November 17 last, the gift has been accepted, and application for a patent in this country has been made by the University of Toronto. It may well be that this University does not altogether realise the fact that there is a strong feeling here against patenting products of value in the cure of the disease, so that the action of the Medical Research Council is viewed with some degree of misgiving. It is plain that the more work there is done both on the properties and on the modes of preparation of pancreatic extracts the better. While it would be absurd to suggest that the Medical Research Council has any desire whatever to obstruct such research, the necessity for any laboratory being unable to do this except by arrangement with the patentees does not seem desirable. The best modes of large scale preparation would surely be discovered in the shortest time by ensuring that any firms having the necessary plant may be free to make any experiments that may seem promising. Every credit must be given to the Medical Research Council in its desire to protect the public from the results of putting on the open market preparations of unknown potency, some inactive, others too powerful. The words used by the Council may be quoted: "The intention of the Council is to promote, in the light of recent experience in Canada, and of such new knowledge as research will gain, whatever enterprise or organisation is best fitted for securing the earliest production of the Insulin extract under proper conditions of safety and control, and so to facilitate, with the least possible delay, a thorough and scientific trial of the new treatment in this country."

We may ask, would not the best way to effect these objects be to announce that the Medical Research Council were prepared to test and certify preparations sent to them? It may be objected that a large amount of work would be involved in the testing of numerous small batches, since the only method known as yet requires the use of rabbits. Here is room for investigation, but in the meantime the difficulty might be avoided by refusing to certify any but large batches. If the Medical Research Council were satisfied that a particular firm had the facilities for making such tests themselves, they might agree to accept this firm's own tests, it being always understood that any preparation was liable to control, and a failure to confirm the makers' statement would be ruinous to their reputation.

But there is a further reason that seems to the writer to make such a course the wiser one. The well-meant gift of Toronto University has unquestionably put the Medical Research Council in a somewhat awkward position. In view of the facts referred to in the earlier part of this article, namely, that active extracts have already been made in this country and methods published, it is clear that any general patent could not be upheld. If Collip's special process were patented, it would be open to a maker to vary the solvent, say by using acetone. The writer has found that acetone is less injurious to enzymes than alcohol is, and it might be worth testing for the purpose of preparing insulin. Even if a patent were granted, it would be a very costly and troublesome process to prosecute for infringement, whereas failure to satisfy the Medical Research Council's test would prevent the sale of any worthless preparation. It is indeed quite possible that the objection taken to the apparent policy of this Council is based on a misunderstanding, and that it will turn out that this policy is essentially what is advocated here.

There is another aspect of the matter which has been brought to notice somewhat acutely by the special circumstances of this case. Whatever may be the object of the University of Toronto, there can be no manner of doubt that those who have given time to, and been put to pecuniary loss by work for, the benefit of humanity ought not to suffer. I am informed that Dr. Banting gave up his medical practice to devote his whole time to the research. It may perhaps be objected that if he returns to practice with the reputation gained, large numbers of patients will come to him. But this does not affect the principle. If discoveries in the medical sciences are not to be patented, the question arises as to how their discoverers are to be rewarded. It is absurd, as well as deterrent, to allow the mental capacities which applied to industry would have brought a fortune, to go unrewarded in science. Men of science do not expect fortunes, but freedom from worry is essential for good work, and would well repay the comparatively small expenditure involved.

It may be remembered that about three years ago a combined committee of the British Science Guild and the British Medical Association considered the problem, and a deputation from them was sympathetically received by Mr. Balfour (now Lord Balfour). Subsequent needs for economy prevented any further action. Naturally, many difficulties as to points of detail arise, such as whether a single gift, on the lines of the Nobel prizes, or annual grants, would be the better method. Again, it may be said that a particular discovery is necessarily based on the work of many predecessors. Or a man's work may not lead at once to any discovery of practical value, although the foundations of future valuable discoveries may be laid. There is much to be said in favour of rewards for good work done, as well as for providing means for doing it. It would probably be found in practice that the difficulties are not so great as might appear. It may be suggested that funds might be voted to the Medical Research Council and to the Department of Scientific and Industrial Research for the special purpose indicated.

The Identity of Geber.

By E. J. Holmyard, Clifton College.

It is generally agreed that the masterpieces of medieval chemical literature are the "Investigation of Perfection," the "Sum of Perfection," the "Invention of Verity," and the "Book of Furnaces," ascribed to "Geber, the Most Famous Arabian Prince and Philosopher." They are written in clear and definite language and are free from the enigmas and allegories which disfigure so large a proportion of alchemical books, and they contain much precise chemical information. The earliest Latin manuscripts of these works appear to be of the late thirteenth century, and they profess to be translations from the Arabic of Jābir ibn Ḥaiyān, who lived in the eighth century A.D.

The Arabic origin of Geber's works was universally accepted until the middle of the nineteenth century, when Kopp first expressed doubts as to their authenticity. Kopp, however, knew no Arabic and was not acquainted with any Arabic works of Jābir, so that his suggestion was merely tentative. Additional evidence was secured by Berthelot, who caused translations to be made of a few Arabic manuscripts containing works ascribed to Jābir ibn Ḥaiyān, and compared these translations with the Latin works mentioned above. He came to the conclusion that Geber's works were European forgeries of the thirteenth century and could certainly not be regarded as translations of works of Jābir ibn Ḥaiyān. Up to the present no one has challenged Berthelot's conclusion, and all historians of chemistry have followed him blindly, without critical examination of the material upon which his conclusion was based. I hope to show in the present article that there is a good deal more in the problem than Berthelot seemed to realise, and, while not claiming to have proved definitely that Geber and Jābir are identical, I believe that the evidence now accumulated renders this identity extremely probable.

It is necessary in the first place to consider the data which Berthelot had at his disposal, and to estimate their value; and secondly, to enumerate the definite points in his argument. A fact of prime importance is that Berthelot was completely ignorant of Arabic and was therefore not in a position to draw conclusions from considerations of style—yet this is what he continually attempted to do. This habit of Berthelot's has been severely criticised by von Lippmann ("Entstehung und Ausbreitung der Alchemie," Berlin, 1919), and I need not enlarge upon it here.

Berthelot's acquaintance with Arabic alchemy was limited in two senses, for, in addition to his want of knowledge of the language, he knew even in translation only thirteen small works, nine of which are attributed to Jābir. While, therefore, one has the greatest admiration for Berthelot's invaluable pioneer work, one is justified in holding that the foundation of the edifice which he reared is somewhat insecure. The more I investigate the subject the more do I feel, with Berthelot's countryman Prof. E. Blochet, that "il faudrait des années d'un labeur ininterrompu pour tirer des manuscrits la doctrine arabe de la chimie." [1]

According to the "Kitāb al-Fihrist," a Muslim encyclopædia of the tenth century A.D., Jābir wrote at least five hundred books, some large and some small. About fifty of these are known to exist, and I have no doubt that many others could be found by diligent search. A study of the extant manuscripts shows that Jābir was very catholic in his learning—he was at once philosopher, physician, mystic, and chemist. It so happens that Berthelot came upon some of the more mystical of Jābir's works, and was therefore led to a wrong conclusion as to his attainments in chemistry.

To come now to the definite points in Berthelot's argument. It will be convenient to give these so far as possible in his own words ("La Chimie au moyen âge," tome i.).

1. La première et la plus essentielle, c'est que le texte arabe renferme certaines des doctrines précises sur la constitution des métaux, que nous trouvons dans les textes latins réputés traduits de l'arabe et attribués [à Geber]; tandis qu'une autre partie de ces doctrines manque complètement dans les traités arabes et paraît dès lors appartenir à une période plus moderne. Ainsi la doctrine des qualités occultes, opposée aux qualités apparentes, est formellement exposée dans les textes arabes de Djâber [Jābir]. . . . Au contraire, aucune allusion n'est faite dans les textes arabes précédents à la théorie de la génération des métaux par le soufre et le mercure.

2. On ne rencontre . . . dans les œuvres arabes de Djâber, de recette précise pour la préparation des métaux, ou des sels, ou de quelque autre substance.

3. Dans ces traités arabes, le langage est vague et allégorique.

4. Aucune doctrine ou fait précis n'est énoncé, aucun personnage n'est cité.

5. (No direct quotation of Geber is made by Albertus Magnus or Vincent de Beauvais, the presumption being that the Latin works of Geber were therefore not known to these two alchemists.)

6. La *Summa* ne contient . . . aucune des formules musulmanes . . . dont [Jābir] est prodigue.

7. (The *Summa* contains an account of the arguments of those who denied the possibility of transmutation. Of this "on n'en trouve aucune trace dans les opuscules arabes de Djâber.")

8. (The style of the *Summa* recalls that of the Schoolmen.)

9. L'auteur (of the Latin works) dit que, d'après lui, il existe, en réalité, trois principes naturels des métaux: le soufre, l'arsenic qui lui est congénère,

[1] Private communication to the author.

et le mercure. Ce sont là, en réalité, des théories nouvelles, postérieures à celles d'Avicenne.

10. (All the *Summa*) "est d'une fermeté de pensée et d'expression, inconnue aux auteurs antérieurs, notamment au Djâber arabe."

11. There is no mention in the Arabic work of nitric acid, *aqua regia*, or silver nitrate, all of which are described in the Latin works.

It will be observed that all these arguments are negative ones, and rest upon the difference between the Latin works and the Arabic opuscules of Jābir known to Berthelot. Up to the present I have not found any Arabic works which can be considered as the originals of the Latin treatises, but that there is much to be said against Berthelot's conclusions will be apparent from the following remarks, which I have numbered to correspond with the preceding quotations.

1. Jābir enunciates the sulphur-mercury theory of metals in the first book of his "One Hundred and Twelve Books" (quoted by Al-Jildakī in vol. i. of the "Nihāyat at-Ṭalab"). He says very definitely that "the seven fusible bodies are composed of mercury and sulphur." Compare this with chap. ii. of the "Investigation of Perfection": "All metallick bodies are compounded of argentvive and sulphur." This is expanded in the "Book of Properties," section 12 (B.M. manuscript), where Jābir advances the theory that all minerals, whether metallic or not, are composed of mercury, sulphur, gold, and sal-ammoniac.

2. Jābir can be quite definite when he likes; the three preparations given below are taken from the "Book of Properties."

(*a*) Section 36. "Take a pound of litharge, powder it well and heat it gently with four pounds of wine vinegar until the latter is reduced to half its original volume. Then take a pound of good *qalī* (crude sodium carbonate) and heat it with four pounds of fresh water until the volume of the latter is halved. Filter the two solutions until they are quite clear and then gradually add the solution of *qalī* to that of the litharge. A white substance is formed which settles to the bottom. Pour off the supernatant water and leave the residue to dry. It will become a salt as white as snow." (*b*) Section 38. "Take a pound of litharge and a quarter of a pound of soda, and powder each well. Then mix them together and make them up into a paste with oil and heat in a descensory. (The metal) will descend pure and white." (*c*) Section 36. "To convert mercury into a red solid. Take a round glass vessel and pour a convenient quantity of mercury into it. Then take a Syrian earthenware vessel and in it put a little powdered yellow sulphur. Place the glass vessel on the sulphur and pack it round with more sulphur up to the brim. Place the apparatus in the furnace for a night, over a gentle fire . . . after having closed the mouth of the earthenware pot. Now take it out and you will find that the mercury has been converted into a hard red stone of the colour of blood. . . . It is the substance which men of science call cinnabar."

3. That many of Jābir's books are couched in allegorical language no one will deny, but in others there is scarcely any trace of allegory (*e.g.*, the "Book of Properties") and Jābir is quite capable of sustaining a closely reasoned argument. Lack of space prevents me from illustrating this point as fully as I could wish, but I may perhaps refer to the "Book of Balances," where he says, "It must be taken as an absolutely rigorous principle that any proposition which is not supported by proofs is nothing more than an assertion which may be true or may be false. It is only when a man brings proofs of his assertion that we say, your proposition is true." Similarly, he is at pains in the "Book of Properties" to make it clear that he is describing his personal experiences; "we have described only that which we ourselves have seen, and not that which was told us or what we heard or read." Jābir is very precise, again, in his "Book of Definitions."

4. Berthelot's fourth argument is sufficiently answered by the evidence I have brought forward in 1, 2, and 3. In his "Book of the Divine Science," Jābir refers to Pythagoras and Plato, and defines chemistry as "that branch of natural science which investigates the method of formation of the fusible bodies" (*i.e.* the metals). His views on the structure of cinnabar, given in the same book, are so precise, and refute Berthelot's charge of vagueness so well, that I cannot refrain from quoting them here.

"When mercury and sulphur combine to form one single substance it has been thought that they have essentially changed and that an entirely new substance is formed. The fact is otherwise, however. Both the mercury and the sulphur retain their own natures —all that has happened is that their parts have become attenuated and in close approximation to one another, so that to the eye the product appears uniform. But if one could find an apparatus to separate the particles of one sort from those of the other, it would be apparent that each of them has remained in its own permanent natural form and has not been transmuted or changed. We say, indeed, that such transmutation is not possible for natural philosophers."

5. If Albertus Magnus and Vincent de Beauvais knew no Arabic, and if the *Summa, etc.*, (supposing that they were originally Arabic) had not yet been translated into Latin, the absence of mention would be explained. In any case, the argument *a silentio* is always unsatisfactory.

6. It is here that Berthelot's ignorance of Arabic has led him astray. As a matter of fact, the *Summa* is full of Arabic phrases and turns of thought, and so are the other Latin works. It is obvious that a full discussion of this point would require far more space than is available here, and I hope to treat of it elsewhere. I will, however, quote one or two passages of Russell's English translation of Geber which are of unmistakable Arabic origin. "Our Art is reserved in the Divine Will of God and is given to, or withheld from, whom he will, who is Glorious, Sublime, and full of all Justice and Goodness." ". . . transmute with firm transmutation" (a well-known construction in Arabic). "This Divine Art, which is both necessary and known." "Now let the high God of Nature, blessed and glorious, be praised, who hath revealed to us the Series of all Medicines." "We have dispersed the special things pertinent to this Praxis, in diverse Volumes" (often said by Jābir). "Gold Obrizon" (dhahab ibrīz). "One part tingeth infinite parts of Mercury into most high Sol, more noble than any natural Gold." "Festination is from the Devil's part."

7. So far, I have not found in Jābir any mention of the arguments against the possibility of transmutation

to which Berthelot refers, but Jābir is never tired of pointing out the errors of other chemists and insisting upon the superiority of his own theories and methods. He even curses them in the manner of the Latin works.

8. The style of the Latin works does indeed resemble that of the Schoolmen, but so does that of many of the Arabic works of Jābir. I would refer especially to the first twelve sections of the "Book of Properties," and to the "Book of Definitions."

9. Arsenic as one of the principles of metallic bodies is referred to by Jābir in Book I. of the "Hundred and Twelve Books" (quoted by Al-Jildakī in vol. ii. of the "Nihāyat aṭ-Ṭalab"). "Arsenic" here refers of course to the arsenic sulphides, realgar and orpiment. It will be noticed that the Latin Geber does not insist upon the necessity of arsenic; in this he is in agreement with Jābir. Both agree in regarding the prime constituents of metals to be sulphur and mercury.

10. I have explained Berthelot's insistence on the difference in style between the Latin works and the Arabic treatises as due to the fact that Berthelot was unlucky in his choice of the latter.

11. I cannot say whether the Arabic Jābir definitely mentions nitric acid, *aqua regia*, and silver nitrate. It is unfortunate that the pages referring to solutive waters are missing from the British Museum MS. of the "Book of Properties," especially as I believe this MS. to be unique. Al-Jildakī mentions a "solutive water" (*ma' al-ḥilāl*) which was used to dissolve out silver from a gold-silver alloy; I presume this must have been nitric acid. Al-Jildakī, however, lived after the date of the earliest MSS. of Geber's works.

I ought to say that I have hitherto examined by no means all of the available material, and that in the present article I have only very roughly sketched out the case for the identity of Geber and Jābir. I hope to deal with the subject much more fully in the future, but the question of the identity of Geber is so important for the history of chemistry that it seemed desirable to publish a preliminary account of some of my conclusions.

The Alleged Discovery of the Virus of Epidemic Influenza.

The recent report in the daily press that the cause of influenza had been discovered by Drs. P. K. Olitsky and F. L. Gates, of the Rockefeller Institute, N.Y., might lead the layman to believe that the problem was solved. There is no published evidence to show that this is correct. The facts are briefly these. Influenza is the greatest pandemic disease known and may be traced to the most remote periods of which we have historic data. One of its great outbursts (1889–1890) coincided with the bacteriological epoch in science, and by means of the technique devised by Robert Koch, one of his assistants, R. Pfeiffer, distinguished by the accuracy of all his work, isolated (1892) a small rod-shaped microbe since universally called *Bacillus influenzæ*. This microbe, not easy to cultivate, was missed by all the investigators before Pfeiffer, but his work was subsequently regarded as correct.

In succeeding years influenza as an epidemic disappeared and little was heard of Pfeiffer's bacillus in bacteriological literature. In 1918, under the title of Spanish influenza, the disease again appeared, and sweeping over the inhabited world like a prairie fire, caused immense morbidity and mortality everywhere. The microscopes of bacteriologists were riveted on the disease processes of the plague. The results of tried investigators varied, but with prolonged experience and suitable methods the bacillus of Pfeiffer was found almost everywhere in cases of the disease. Dissentient voices were, however, raised here and there, partly owing to inability to find the bacillus, partly owing to the fact that when found it was difficult to prove its causal relation to influenza, as animals are by no means so susceptible to the disease as man.

It was believed and stated, in fact, that Pfeiffer's bacillus was not and could not be the cause of influenza, which was to be sought in some hitherto unknown or unrecognised agent. Among those who held this view must be mentioned Gibson Bowman and Connor, who, attached to the B.E.F. in France, published statements (1919) to the effect that influenzal secretions which had been forced through bacterial-proof filters, gave rise in monkeys, rabbits, mice, and guineapigs to a disease closely resembling that of human influenza. They claimed to have transmitted the disease from animal to animal in series. They believed that the virus was a "filter passer." Independently, Bradford, Bashford, and Wilson made similar claims, which they afterwards withdrew. Following the same lines, Maitland, Cowan, and Detweiler of Toronto recorded entirely negative results and directed attention to grave errors which might arise in interpreting results believed to be positive. What were described as typical effects by the supporters of the filter-passing-virus theory were shown by the Canadians to occur in animals that had never been inoculated at all but which had been intentionally killed. This fact has since been abundantly confirmed by Branham (1922) and shown by her to occur when death is brought about by a blow on the neck. It is along the same route that the Rockefeller investigators have proceeded, from whose work it is now claimed that the etiology of influenza is settled, and it is claimed that the virus is a body called by them *Bacillus pneumosintes* (σίντης, injurer or devastator—from its supposed deleterious effect on the lungs).

In the last two years Olitsky and Gates have published a long series of papers in the *Journal of Experimental Medicine*, giving the results of their inquiries. Their claims are based on the following statements. (1) Influenzal throat secretions diluted and filtered through Berkefeld filters produce symptoms which cannot be produced by similar filtrates from normal persons. The symptoms—in rabbits—are fever, conjunctivitis, and a diminution in the number of leucocytes in the blood, a symptom which is very characteristic of the influenza disease in man. None of the animals died of the experimental disease, but on being killed, the lungs were found mottled and hæmorrhagic. (2) The lesions in the lungs are said to be transmissible in series. (3) Although none of the experimental animals died, they are stated to have been rendered more susceptible to a later infection by Pfeiffer's bacillus. (4) In the filtered washings peculiar "bacilloid" bodies were found measuring 0·15–0·30 μ in their long dimension. The nature of these bodies—at first uncertain—was ultimately believed to be micro-organismal. Hence the name *Bacillus pneumosintes*. (5) Inoculation of cultures of the so-called bacillus followed by injections of *B. influenzæ* resulted in the production of consolidation of the lungs with hæmorrhagic œdema and emphysema. (6) A certain degree of immunity is stated to follow injections of *B. pneumosintes*. (7) Inoculation of the bacterium is stated to evoke certain antibodies which are of a specific character. It may be stated that "cultures" of the microbe were obtained only on the highly complicated Smith-Noguchi medium, and especially under anaerobic conditions.

Before assuming that all these statements are correct it may be stated with respect to this microbe—if it is a microbe—that bacilloid and other like bodies indistinguishable in appearance from *B. pneumosintes* may occur in tubes of Noguchi's medium which has never been inoculated at all and nevertheless is sterile. The "bodies" appear to be due to some transformation of the colloid material of the medium itself. Such transformations may occur in tube after tube and give rise to the erroneous interpretation of successful transmission of the culture. Further, it is remarkable that the "microbe" does not kill the experimental animals, but that when they are killed afterwards they show changes admittedly indistinguishable from those seen in killed animals never inoculated. One great obstacle to the successful study of influenza would appear to be that animals are much less susceptible than man, and that as soon as the question of human inoculation is introduced, great difficulties ensue in excluding other sources of infection. Recently, Lister in South Africa, working on lines identical with those of Olitsky and Gates, has found, like them, *Bacillus pneumosintes* or similar "culture," but on inoculating such unheated cultures into human beings, 13 in number, he had only one success, a typical attack of uncomplicated influenza, after a nineteen-hours incubation period. It may be that the cause of influenza has been located in *B. pneumosintes*, but before this can be accepted by the bacteriological world in general it will be necessary to adduce many more cogent reasons than have been forthcoming so far.

W. B.

Obituary.

Prof. Fritz Cohn.

Fritz Cohn, director of the Berlin Rechen-Institut, died on December 14 after an operation. He was born at Königsberg on May 12, 1866, and studied first at the Gymnasium and afterwards at the University there; after further study at the University of Berlin he was placed on the staff of the Königsberg Observatory in 1891 and remained there till 1909.

Cohn's work included a discussion of Bessel's observations between 1813 and 1819, and a determination of the declinations and proper motions of the stars used in the International Latitude stations. He published catalogues of the stars used for the Eros campaign in 1900–1, and of 4066 other stars observed with the self-registering micrometer of the Repsold transit circle.

In 1909, Cohn was appointed to the chair of theoretical astronomy at Berlin, and director of the Rechen-Institut. He took part in the Paris Conference of 1911 which arranged for combination of work between the national almanacks, to avoid needless duplication of labour. The time thus saved was devoted to investigations on the minor planets, and the Institut took the leading part in deducing their orbits, and in arranging plans for sharing the observing work among different observatories. He showed great skill in keeping up the necessary accuracy of computation without any waste of labour. He also carried on the Astronomisches Jahresbericht after the deaths of Wislicenus and Berberich, and left the MS. for the 1921 volume practically complete at the time of his death.

Cohn married a daughter of C. F. W. Peters, director of Königsberg Observatory, in 1898, and leaves a son and two daughters. A fuller account of his life and work is given by J. Peters in *Astr. Nach.* 5208.

Cohn was elected an associate of the Royal Astronomical Society in June 1913.

A. C. D. C.

Mr. P. C. A. Stewart.

It is with much regret that we record that Mr. P. Charteris A. Stewart, the well-known petroleum geologist and consultant to Viscount Cowdray's firm (Messrs. S. Pearson and Co.), met his death by drowning while bathing at Balandra Bay, Trinidad, B.W.I., during a recent short visit to the Islands.

For nearly twenty years Mr. Stewart has been connected with Messrs. Pearson's, and he had been closely associated with that firm in its important petroleum developments all over the world, more particularly in Mexico, Roumania, and Trinidad. Prior to this he held an appointment on the staff of the Geological Survey of Egypt.

Mr. Stewart's technical education was at the Royal School of Mines, where, in 1900 and 1901, he obtained diplomas in mining and metallurgy. Returning in 1904 he gained a further diploma in geology at the Royal College of Science in 1905. He was elected a fellow of the Geological Society of London in 1904, and was also a member of the Institution of Petroleum Technologists and the American Institute of Petroleum Geologists.

Mr. Stewart had travelled much, and by his wide experience and intimate knowledge of oilfield conditions in many countries he gradually built up a high reputation in his profession. His sound judgment in technical problems, backed by conscientious inquiry and skilful reasoning, made him an invaluable adviser to those whom he was privileged to serve. His death at the early age of forty-eight is a deplorable loss, one which will be keenly felt, not only by his colleagues, but also by his many friends, to whom he had endeared himself as a kindly, modest, and unselfish man.

H. B. M.

Current Topics and Events.

Since the publication of the letter "On the Missing Element of Atomic Number 72," by Dr. Coster and Prof. Hevesey, in Nature of January 20, p. 79, it has been announced that Dr. Alexander Scott detected and separated the oxide several years ago. It appears that while examining in 1913 a specimen of titaniferous iron sand (75 per cent. Fe_3O_4, 25 per cent. TiO_2) from near Maketu in the North Island, New Zealand, Dr. Scott noticed that in the titanium dioxide separated in the ordinary methods of analysis there was always a small residue which resisted all attempts to get it into solution, either as sulphate, chloride, or nitrate. Neither would it go into solution after prolonged fusion with caustic soda. No trace of the many "rare earths" was found in the sand. The insoluble residue remaining after repeated and alternated fusions with sodium bisulphate and caustic soda was labelled "New Oxide" in 1918. Its properties and mode of occurrence indicated that it was an oxide of the titanium-zirconium group, and that it was the oxide of the missing element, of which the atomic number is 72. Some of its properties showed a resemblance to tantalum, its next neighbour, with the atomic number 73; but all traces of this element would be removed by the repeated fusions with caustic soda. As none of the ordinary salts were available for the purpose of determining the atomic weight, recourse was had to the double fluoride with potassium, which closely resembles those of titanium and zirconium. The rough determinations with material imperfectly purified for such a purpose indicated that the atomic weight of the element was between 1½ and 2 times that of zirconium (90·6). The oxide resulting from these determinations was of a cinnamon-brown colour, not white as was expected. We understand that Dr. Scott wrote on January 28 to Drs. Coster and Hevesey offering to send them specimens of his separated material to compare with their own, and received a reply from them on Saturday night last (February 3) saying they would be very glad to do so. On Monday Dr. Scott sent to them practically all his purified material, and not only he, but also all scientific men, must await with keen interest the result of the searching examination by means of the powerful appliances in their hands for spectral analysis by X-rays. In view of the source of his oxide and its association with much titanium oxide, Dr. Scott has suggested, as Oceanus was one of the Titans, that "Oceanium" would be a suitable name for the element. This name would also recall that the sand came from Oceania, of which New Zealand is one of the component parts.

The Bakerian lecture of the Royal Society will be delivered on February 22 by G. I. Taylor and C. F. Elam on "The Distortion of an Aluminium Crystal during a Tensile Test."

The Duke of Devonshire will open the new Botany (Plant Technology) Building of the Imperial College of Science and Technology, South Kensington, on Friday, February 16, at 3 o'clock.

At the meeting of the Chemical Society to be held at the Institution of Mechanical Engineers (Storey's Gate), on Thursday, February 22, at 8 p.m., Principal J. C. Irvine will deliver a lecture entitled "Some Constitutional Problems of Carbohydrate Chemistry."

The Murdoch Trust, Edinburgh, grants donations or pensions to indigent bachelors and widowers of upwards of fifty-five years of age who have done something to promote or help some branch of science. Particulars are obtainable from Messrs. J. and J. Turnbull, 58 Frederick Street, Edinburgh.

A social evening of the Royal Society of Medicine will be held on Wednesday, February 28, beginning at 8.30. It will be devoted to the celebration of the centenary of Pasteur. At 9 o'clock the president, Sir William Hale-White, will deliver an address on "The Life and Work of Pasteur." This will be followed by an illustrated lecture by Dr. G. Monod on "Pasteur as an Artist."

On Tuesday next, February 13, at 3 o'clock, Prof. A. C. Pearson will deliver the first of two lectures at the Royal Institution on Greek civilisation and to-day —(1) The beginnings of science, (2) Progress in the arts; on Thursday, February 15, Prof. B. Melvill Jones will begin a course of two lectures on recent experiments in aerial surveying; and on Saturday, February 17, Sir Ernest Rutherford will commence a course of six lectures on atomic projectiles and their properties. The Friday evening discourse on February 16 will be delivered by Prof. A. V. Hill on muscular exercise; and on February 23, by Prof. A. S. Eddington on the interior of a star.

Notice is given by the Royal Society of Medicine that the William Gibson research scholarship for medical women will be awarded in June next. The scholarship is of the value of 250*l*. for two years and is not necessarily for research, the selected scholar being free to travel. Full particulars will be sent on application to the Secretary of the Society, 1 Wimpole Street, W.1.

During the making of the new road between Dover and London numerous sarsen stones were found among the remains of the Lower Tertiary formations overlying the chalk near Maidstone. Two of these, selected by Mr. G. E. Dibley, were sent to the British Museum (Natural History), where they are now exhibited in the geological department close to the stratigraphical collection. They are remarkable for their botryoidal concretionary form.

A meeting of national importance has been arranged by the British Science Guild to be held at the Mansion House, London, on Tuesday, February 27, at 3.30 p.m., to direct public attention to the importance of promoting efficiency and economy in industry, commerce and all Imperial affairs by the progressive use of science and scientific method. The Right Hon. the Lord Mayor will preside, and will be supported by the Right Hon. Lord Askwith, president of the Guild. The speakers will include Sir Joseph Thomson (Master of Trinity College, Cambridge), Sir Robert A. Hadfield, Bart. (Vice-President of the Federation of British Industries), and the Right Hon. Sir Joseph Cook, G.C.M.G. (High Commissioner for Australia). Tickets may be obtained from the Secretary, British Science Guild, 6 John Street, Adelphi, London, W.C.2.

THE president and council of the Royal Society have appointed Prof. E. H. Starling first Foulerton professor in accordance with the terms of the bequest of Miss Lucy Foulerton, who left the residue of her estate to the Royal Society. The duties of the professor are to conduct such original researches in medicine or the contributory sciences as shall be calculated to promote the discovery of the causes of disease and the relief of human suffering. Prof. Starling's work will be carried out at University College, London. Dr. H. W. C. Vines, fellow of Christ's College, Cambridge, has been appointed to a Foulerton research studentship, the duties being to conduct researches in medicine or the contributory sciences. Dr. Vines is carrying on his researches in the Cambridge Medical School.

AT the annual general meeting of the Association of Economic Biologists held on Friday, January 26, the following officers and council for the year 1923 were elected: *President*: Prof. E. B. Poulton. *Vice-Presidents*: Prof. V. H. Blackman and Sir John Russell. *Treasurer*: Dr. A. D. Imms. *Secretaries*: (General and Botanical): Dr. W. B. Brierley; (Zoological) Dr. J. Waterston. *Editors*: (Botany) Dr. W. B. Brierley; (Zoology) Mr. D. Ward Cutler. *Council*: Dr. W. F. Bewley, Prof. V. H. Blackman, Mr. F. T. Brooks, Mr. A. B. Bruce, Dr. E. J. Butler, Dr. J. W. Munro, Sir John Russell, Prof. J. H. Priestley, Prof. J. H. Ashworth, Dr. T. Goodey, Mr. A. D. Cotton, and Mr. W. E. Hiley.

A JOINT meeting of the Society of Public Analysts and the Nottingham Section of the Society of Chemical Industry was held at Nottingham on January 17 for the discussion of methods of estimating arsenic. The chair was taken by Mr. Burford, chairman of the Nottingham section, and the discussion was opened by Mr. A. Chaston Chapman, who described his experience during the last twenty-five years with the zinc-acid process, and gave an outline of his procedure, more particularly in the use of cadmium to render the zinc sensitive. He was followed by Mr. Wilkie, secretary of the Nottingham section, who demonstrated the use of his electrolytic method of estimating arsenic, in which the reversibility of the reaction was prevented. Dr. Monier-Williams showed an electrolytic Marsh apparatus modified from that in use in the Government laboratory. Mr. H. Droop Richmond attributed the want of sensitiveness of the zinc in the zinc-acid method to the presence of iron, and Mr. J. Webster described an experiment indicating that the total amount of arsenic in a large organ such as the liver was correctly estimated by multiplying the amount found in the Marsh test by a factor.

THE New York correspondent of the *Times* states that an earthquake of considerable violence was recorded in the United States on February 4. A sea wave 12 feet high is reported at Hilo Harbour, Hawaii, and a number of small boats were lost at Waiakea. Four waves passed over Haleiwa, some thirty miles from Honolulu, which does not appear to have suffered important damage. The cable between Midway Island and Guam appears to be broken, and attempts to reach Samoa by wireless were unsuccessful. Mr. J. J. Shaw, of West Bromwich, Birmingham, states in the *Daily Mail* that the primary movement began on Saturday afternoon at 4 h. 13 m. 15 s., and the secondary at 4 h. 23 m. 4 s., indicating a distance of 5300 miles. The earth tremors continued for upwards of six hours. The needle was thrown off the record several times. Mr. Shaw states that the disturbance is the biggest recorded since the Chinese earthquake of December 1920.

THE annual meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 10 and 11, at the Institution of Civil Engineers, Great George Street, London, S.W.1. The council has received a very cordial invitation from Mr. G. E. Falck, president of the Associazione Fra Gli Industriali Metallurgici Italiani, for the members of the Institute to meet in Italy in the autumn of this year. Subject to final arrangements with the Italian Association, the general meeting will be held at Milan about the middle of September, and on its conclusion it is proposed that visits should be paid to the principal metallurgical centres and to the hydro-electric power stations in Italy. The tour will also include visits to Rome, Naples, Genoa, and Turin, and is expected to occupy altogether about nineteen to twenty days from the time of leaving London until the return.

AT the recent annual meeting of the American Association, held at Boston, the Association as a whole declared itself unqualifiedly in favour of the metric system of measurement with one of the strongest resolutions ever passed by that body on this subject. The resolution is as follows: "Whereas the metric system of weights and measures has not yet been brought into general use in the United States, and whereas the American Association for the Advancement of Science has already passed resolutions favouring the adoption of the metric system of weights and measures in the United States; therefore be it resolved: That the American Association for the Advancement of Science reaffirms its belief in the desirability of the adoption of the metric system of weights and measures for the United States, and recommends that the units of the system be used by scientific men in all their publications, either exclusively or else with the customary non-metric units in parenthesis."

THE exhibition of facsimiles and reproductions of old maps in the Whitworth Hall of the University of Manchester during the last week of January coincided with the news that the Council of the University decided at the last meeting to recommend to the Court the institution of an honours school of geography within the faculty of arts. The exhibition, arranged jointly by the Manchester Geographical Society and the University, was opened by Sir Frederick Lugard, and the occasion was taken to bring before the public the appeal for funds which the Society is making to endow a chair of geography in the new honours school. The collections of maps, which have been placed on loan at the University by Col. D. Mills and Mrs. Booker, include facsimiles of such maps as the Madaba Mosaic, the Peutinger Table, the St. Sever copy of the Beatus map, 14th and 15th c. portolani, the Catalan world map of 1375, and the series of maps reproduced principally under the direction of Prof. E. L. Stevenson, illustrative of geographical discovery in the period between the time of Juan de la Cosa's portolan (1500) and the world map of Hondius (1611). The Booker collection contains many typical country and county maps from Norden and Saxton to Cary, Greenwood, and Bryant, while the reproductions of London and Paris views and maps (Mills collection), made by the London Topographical Society and the French Government respectively, form excellent material for the study of these two cities. In addition, the exhibition includes a number of regional maps of the various parts of the world extending over a considerable period of time, of which those of Russia and the Far East are the most extensive. There is every prospect, with these maps as a nucleus, of a great development of all phases of cartographical studies within the University.

Messrs. W. Watson and Sons, Ltd., of 313 High Holborn, W.C.1, have issued a new edition of Parts 1 and 2 of their microscope catalogue. Included in the list is a new model, the "Kima," which is specially designed for students and sold at a reasonably low price. The instrument, which is somewhat similar to, but smaller than, the now well-known "Service" model, complies with the specification of the British Science Guild except in regard to the position of the fine adjustment milled heads. Various models—for example, the "Royal," the "Van Heurck"—suitable for research or general high power work, as well as binocular microscopes for both low and high powers are described in detail and a complete list of eyepieces, objectives, condensers, and other accessories is given. A welcome reduction in prices is noticeable in nearly all the items. There is also listed a horizontal or reading microscope consisting of a microscope body of large diameter fitted with a micrometer eyepiece and a 2-inch objective. The body is surmounted by a sensitive bubble for levelling purposes. Vertical adjustment is made by a rack and pinion, the pillar being divided into millimetres and fitted with a vernier.

The Pasteur lecture delivered before the Institute of Medicine of Chicago on November 24 last, by Dr. Jacques Loeb, is reproduced in the issue of *Science* dated December 29. The lecture is devoted mainly to a consideration of the osmotic equilibrium of gelatin in the presence of various concentrations of acid and alkali.

We have received the new issue of the chemical catalogue of British Drug Houses, Ltd. In many cases there has been a considerable reduction in prices of chemicals in everyday use, and some substances required by research workers are now listed which did not appear in former catalogues. Biological stains are included, and the catalogue should find a place in every laboratory.

In the January issue of the Research Defence Society's pamphlet, *The Fight Against Disease* (Macmillan and Co., price 6*d*.), the story of bubonic plague, by Surg.-Gen. Bannerman, is retold (the Society first published it in 1910). An excellent account is given of the ravages of bubonic plague and its transmission from rats to man through the intermediary of the rat fleas. Some data are also included of the efficiency of plague vaccine in the prevention of the disease. The general article on Pasteur which appeared in Nature, December 23, is also reprinted.

Our Astronomical Column.

Fireballs in February.—Mr. W. F. Denning writes: "This month though it does not supply meteors in abundance has furnished a number of large fireballs, some of which have been of exceptional character. The Mon. Not. R.A.S. for March 1922 contained a list of the remarkable meteoric phenomena recorded in recent years between February 7 and 22. Two of the most singular fireballs ever seen occurred, one on February 22, 1909, which left a long streak in the sky for two hours and drifted on upper wind-currents to north-west at the rate of 120 miles per hour. The other, on February 9, 1913, consisted of a stream of bright meteors which passed over North America, and had a luminous flight extending over at least 5500 miles.

"It is impossible to foretell the time of appearance of any individual fireball, and it is necessary that observers should be specially on the alert during the present month, for the prospect of observing a large meteor is very good, especially during the periods February 7, 10–14 and February 19–22. There are several active radiants at this time of the year such as those at $147°-11°$, $167 +33°$, $73°+42°$, and $106°+52°$. In the event of any bright meteors being seen, the particulars should be carefully noted, and their apparent paths among the stars recorded as accurately as possible."

Astronomical Circulars.—There is a class of astronomical announcements—discoveries of comets or of novae, unusual markings on planets, etc.—the early circulation of which is of importance to observers. In the last century Lord Crawford started the Dunecht and Edinburgh Circulars, but they were not continued after his death. The only resource up to the present for those who find the price of astronomical telegrams too high has been the series of circulars issued by Prof. Strömgren at Copenhagen, or that of the *Astr. Nach.* at Kiel. These take some days to reach this country. The British Astronomical Association has now decided to issue a series of circulars when news of an urgent character comes to hand. Non-members of the B. A. A. can obtain these circulars at a charge of a few shillings per annum on writing to the secretary. They will include the latest ephemerides of comets in addition to discovery announcements.

Research Items.

The Faroe Islands.—The Faroe or Sheep Islands, lying half-way between Iceland and the Shetlands, are inhabited by people of Norwegian descent. In these islands an energetic linguistic movement has recently arisen, aiming at elevating the local idiom to the rank of a language, a movement which is not political, but suggested by the declaration in 1918 of the independence of Iceland. Mr. J. Dyneley Price, in the Proceedings of the American Philosophical Society (vol. lxi. No. 2, 1922), describes the linguistics and phonetics on information furnished by Miss M. E. Mikkelsen, a Faroese lady now resident in Copenhagen. It is curious that this movement extends to a new form of spelling which, like the stereotyped archaic spelling of modern Gaelic, ignores the modern phonetics of the spoken dialects.

An Ancient Australian Skull.—Anthropologists will read with considerable interest a paper in the *Journal of Anatomy* (vol. lvii. part 2) by A. N. St. G. H. Burkitt and Prof. J. I. Hunter on "A Description of a Neanderthaloid Australian Skull." This was that of a female, and was "Neanderthaloid" only in so far as the calvarium was concerned. The excessive development of the supraorbital ridges of this skull the authors ascribe largely to the action of the masticatory muscles; but their arguments in favour of this interpretation, which are shared by others, are not convincing. In the conclusions at which the authors have arrived, we hoped to find some expression of opinion as to the precise relationship of this skull—and of the Australian aborigines in general—to Neanderthal man. But on this matter no direct views have been advanced. The authors applied several tests to discover the alveolar index of this skull. "Flower's Gnathic Index," they remark, "places it well within the limit of orthognathic skulls, the index being 95·23." The base line devised by Pycraft gives an index of 96, when applied to the photograph of the skull on Plate I. We venture to think that the authors have laid undue stress on the "Neanderthaloid" characters of this skull, and we are puzzled by the cryptic statement that "we must regard the cranial resemblances as an expression of the principle that descendants of a common ancestor show a tendency to develop independently similar features."

Nitrogen Fertilisers for the Sugar Cane.—In the *Archief voor de Suikerindustrie in Nederlandsch Indië* (1922, Mededeelingen No. 3) J. Kuyper describes experiments carried out in Java on the relative value of several nitrogen fertilisers for sugar-cane cultivation. The trials have been carried out for several years in comparison with sulphate of ammonia, of which the average amount used is about 380 lb. per acre. In all cases the same weight of nitrogen was given in the different manures. Urea and nitrate of soda proved to be equal in value to ammonium sulphate, but the nitrate is too hygroscopic for convenient use. The same objection applies to ammonium sulpho-nitrate, especially in the tropical rainy season. Nitrolim or cyanamide and beancake are both of less value. Beancake does better on some soils than others, and is improved by the admixture of a certain proportion of sulphate of ammonia.

Pasture Grass in Tropical Africa.—It is difficult to overestimate the importance of the contributions to colonial development that may be made by the work of institutions such as the Royal Botanic Gardens, Kew. The *Kew Bulletin* (No. 10, 1922) contains a typical example of the type of information which the resources of such a central institution can so readily place before various interested outliers of Empire. In western tropical Africa one of the difficulties in the way of pasturing fertile country lies in the ravages of the tsetse fly and the epidemics it engenders. Mr. T. M. Dawe, making an agricultural survey of Angola in 1921, recognised in the native "Efwatakala grass" a fodder plant similar to a Brazilian grass already known to him as capable of fattening stock. This grass was widely distributed in the Portuguese Congo, and on its receipt at Kew it proved to be *Melinis minutiflora*, Beauv., *f. inermis*, already reported upon in the *Kew Bulletin* (1900) as "Brazilian stink-grass." Dr. Stapf's report in the present bulletin fully bears out Mr. Dawe's view that the grass should prove a rapid coloniser of open ground and then form a fairly permanent pasture. Its potential value lies, however, in the insecticidal or insect-repelling qualities of an oil secreted in glandular hairs upon the leaf-sheath and lamina. The grass has now been grown upon a small scale at Kew, and the Jodrell Laboratory supplies a note upon the structure of the glandular hairs while the Wellcome Research laboratories have made a preliminary study of the small quantity of oil that could be extracted from the available crop of the grass. Mr. Dawe apparently hopes that this grass may prevent the spread of the tsetse fly at the same time that it provides food for stock. If such anticipations are realised the ultimate possibilities of its cultivation in tropical Africa are incalculable. It would be interesting to learn why the attempt at its introduction into Australia, chronicled in the earlier note in the *Kew Bulletin*, seems to have been without result.

The Palolo Worm.—Dr. Glanvill Corney, who was for many years chief medical officer of Fiji, contributes an interesting paper to the Journal of the Torquay Natural History Society on the periodicity of the sexual phase of the "Palolo" worm in Fijian waters. This worm (*Eunice viridis*) lives in the coral skeletons and rocks of the reefs, riddling them with its burrows. Like most bottom-living marine animals, its eggs are cast on the mercy of the waves and currents to be distributed far and wide. While most boring worms are content merely to shed their eggs into the bottom waters, several kinds, including the Palolo, cut off the hinder parts of their bodies, which are crowded with generative cells; these float to the surface of the water, each segment rupturing and setting free its sexual cells: this is known as swarming. The first phase of development is a floating one, but the larvæ soon settle and form their burrows. Annually the worm sheds its hinder sexual part into the water and re-forms it. The peculiarly interesting feature of the life history is the regularity with which this phenomenon occurs. As usual in such forms, the generative organs are ripe in the spring of the year, when there is a peculiar outburst of all life. The Palolo swarm on the same day, the surface of the sea at dawn becoming thick with their bodies. The day selected at Fiji is recorded by Dr. Corney for 25 years and is shown always to be on the morning of the seventh to ninth days after full moon in November or early December; the interval between swarming is sometimes 353-6 days and at other times 382-6 days, either 12 or 13 lunar months. A few may swarm a month earlier at the corresponding neap tide, but this small swarm is often unrecognisable. The vast quantities of sexual Palolo in the surface waters, like a thick macaroni soup, is a striking phenomenon enough, but it is one greatly enhanced by other eunicids, other worms, many crustaceans, and other animals all breeding in the same days of lowest tides, when the reefs are subjected to the greatest amounts of heat and light; indeed, similar sexual correlations with solar and lunar phenomena have now been suggested in nearly every group of animals.

THE ETESIENS IN THE MEDITERRANEAN.—An article is given in the U.S. *Monthly Weather Review* for August 1922, by Mr. J. S. Paraskévopoulos, of the National Observatory, Athens, on the etesiens, the characteristic north winds which blow during the summer in the region of the eastern Mediterranean. The marked regularity of these winds was observed by the ancient Greeks and the name signifies "winds blowing periodically every year." The author has tabulated the data for several Greek meteorological stations, and for a period extending over 15 years, 1900–14; the observations are made three times daily, at 8 A.M., 2 P.M., and 9 P.M., while for Athens the observations are continuous from self-recording instruments. The etesiens blow generally from the second 10-day period of May until the middle of October, with two periods of maximum. During June the winds are interrupted; in July and especially in August they are much more steady and frequent. In Athens before the middle of July the etesiens blow during the morning and are replaced in the afternoon by the sea breeze. The principal features of these winds have been known since the time of Aristotle. The anemometric data at Athens show that the velocity of the etesiens undergoes a very distinct diurnal oscillation; the speed during the daytime varies from 11 to 27 miles per hour, and it seldom reaches 45 miles per hour. Information is given as to their origin, with respect to the distribution of atmospheric pressure, temperature, and humidity. As they contribute largely to the dryness of the soil, they raise by their motion great quantities of dust.

THE HUMBOLDT CURRENT.—Variations in the temperature of the Humboldt current have been noted for many years and were recently examined by Mr. R. C. Murphy, who contributes an article to the *Geographical Review* for January on the oceanography of the Peruvian littoral. The uniform temperature conditions of this current are carried southwards from Peru at least so far as Valparaiso. Throughout this extent the lowest surface temperatures are in the inshore waters and are due to the upwelling of bottom water which is the feature of this current. The steeper the coastal slope, the greater is the reduction of inshore temperatures. Irregular variations in temperatures, which occur locally throughout the year, have been generally attributed to a shifting in the course of the current. Mr. Murphy believes that the cause is to be found in the northerly winds which accompany these abnormal sea temperatures. These winds drive warmer waters inshore and temporarily check the upwelling. More prominent is the current known on the Peruvian coast as El Niño. This countercurrent of tropical water is felt seasonally north of about lat. 8° 13′ S. Mr. Murphy demolishes the theory that El Niño is due to the waters of the River Guayas and holds that it can be correlated with changes in barometric pressure when the sun is south of the equator. The paper ends with some interesting correlations between the temperature variations of the Humboldt current, the distribution of plankton, and the valuable guano birds of the Pisco Bay region. The invasion of warm water destroys enormous quantities of plankton. The result is that the birds either migrate or have to face a loss of food supply. The latter course leads to a lowering of vitality and considerable reduction in numbers as the outcome of certain prevalent diseases which attack the weakened birds.

EARTHQUAKES OF THE EAST INDIAN ARCHIPELAGO.—In a recent important memoir (Konin. Magnet. en Meteorol. Observ. te Batavia, Verhandelingen No. 7, 1921) Dr. S. W. Visser has investigated the distribution of earthquakes in the East Indian Archipelago from 1909 to 1919. The positions of the epicentres were determined from seismograms at the observatories of Batavia, Malabar, Manila, Sydney (Riverview), and Zikawei. Earthquakes strong enough to be registered at two or more of these observatories (160 near Western Java and 120 in other parts of the Archipelago) are confined as a rule to four principal regions—the Indian Ocean off southern Sumatra and western Java, the Celebes Sea and the Pacific Ocean south of Mindanao, the southern and eastern borders of the Banda Sea, and the mountain ranges of New Guinea. With the exception of the last region, the seismic zones of the Archipelago coincide with the steeply sloping sides of oceanic troughs in the close neighbourhood of the islands. The bottoms of the Indian and Pacific oceans far from land are probably nearly or quite aseismic. In a second memoir (Verhandelingen No. 9, 1922) Dr. Visser studies the earthquakes with an inland origin in Sumatra and Java only, the materials for the other islands being insufficient. They are few in number. For example, during the thirteen years 1909–1921, 13 earthquakes out of 859 in Sumatra, and 6 out of 748 in Java, had an inland origin. The distribution of inland earthquakes in Sumatra is simple and regular. Most of the epicentral areas coincide with a long fracture which has given rise to an important series of longitudinal valleys in the Barisan mountain ranges. In Java the distribution is less regular. Violent earthquakes have occurred on the slopes of some volcanoes (for example, Mount Gede and Mount Tjerimai). They were, however, of tectonic origin, the proximity of volcanoes being only a coincidence or due to their connexion with the same zones of weakness. At the times of severe earthquakes the activity of the volcanoes was either slight or altogether absent.

TROUTON'S LAW.—When in 1884, in volume 18 of the *Phil. Mag.*, Trouton showed that for a number of liquids the molecular heat of evaporation at the normal boiling-point was 20 times the absolute temperature at that point, the data by means of which the law could be tested were scarce and the accuracy of the values available not great. Additional and more trustworthy data were provided by Louguinine in 1896–1902 and the law shown to hold to within 10 per cent. for groups of liquids of similar constitution, but to be sometimes 50 per cent. in error when, for example, alcohols were compared with organic acids. Further work has disclosed many exceptions and attempts have been made to find temperatures other than the normal boiling-points at which the comparison would give more consistent results. These have, however, been unsuccessful, and in the January issue of the *Phil. Mag.*, Mr. S. B. Mali, of the University of Calcutta, states that there is no temperature at which the law holds, that it has no theoretical significance, and that it is an accident that it appears to hold for some substances at their normal boiling-points. This may be the correct view, but it is still remarkable that many liquids should fall into the accidental group.

Can Gravitation really be absorbed into the Frame of Space and Time?

By Sir JOSEPH LARMOR, F.R.S.[1]

AN answer to this question in the negative has been advanced in a previous paper on the gravitational deflection of light (*Phil. Mag.*, Jan.). The destructive paradoxes concerned with the recent gravitation theory, which were unfolded by M. Jean Le Roux, professor at Rennes, in three notes in the *Comptes rendus* (Nov. 6, Dec. 4 and 22), after that paper was completed, were referred to in a footnote in support of this departure from the familiar answer. These objections require to be further considered; for at first sight they are destructive to all such theories, including the modification there substituted. If an orbit is postulated to be a curve of minimal length in a fourfold expanse of space-time, the element of length (or distance-interval) must be expressed for it locally, and can involve as variables only its own co-ordinates and their differentials. Yet in the cases that have been worked out, the element as determined involves also the concurrent co-ordinates of the other interacting masses; with all these variables present, it could not belong to a curve in a fourfold at all. This destructive dilemma applies very widely.

There may be a suggestion to evade it, in the theory as modified into one of dynamical Action, along the line (already indicated by A. A. Robb) that the idea of distance cannot subsist in the pseudo-space at all. For within an infinitesimal fourfold spherical domain with radius a very small interval *ds*, the co-ordinates would have an infinite range of values. The idea of locality, essential to real space, is thus absent. The fourfold expanse could still be utilised to express conveniently the domains of integration: but where distances have to enter they must be in threefold real space, though it can be variable and be associated with time also variable. Such real spaces and times would be locally not unique; they constitute a Lorentz group of interchangeable forms. The modified gravitational scheme of the previous paper, with its reduction of the influences on radiation to one-half of the accepted values, might, merely by avoiding the idea of fourfold interval interpreted as a geometric distance, possibly still manage to evolve as a dynamical formulation.

But this train of ideas need not be pursued; for in fact the criticism, which seems destructive of a quasi-geometric scheme for gravitation, does not inhere at all in the dynamical domain of Action. The type of procedure for minimising the total Action, when more closely exhibited, would run in principle as follows. Assume some approximate specification for the orbital paths in the fourfold, close of course to the Newtonian solution. The orbits thus assumed will determine the nature of the fourfold space-time expanse (namely ds^2) already adjusted to minimal Action, in which they exist. For each such specification calculate the density of Action in this fourfold expanse, after the manner of approximate modifications as developed by Einstein; and thence find by integration the total Action of the system corresponding to these assumed orbital forms. The forms of the orbits would enter in the expression for the linear element *ds* defining the space determined by these orbits and necessarily containing them. By taking varied forms of the orbits, different forms of *ds* and different values of the total Action would be obtained. The aim would be to adapt the forms of the orbits so that the Action thus determined from them should remain stationary for all slight variations. The way to carry this out would be to minimise the Action further for joint variation of all the orbits, exactly on the lines of the previous paper. The space itself, being determined by the orbits, also changes as the orbits are varied; and it is not at all involved that *ds* remains the elemental distance in the *same space* throughout the procedure.

It would appear then that the Minkowskian method of fourfold spatial analysis as generalised by Einstein for adaptation of gravitation into the optical and electrodynamic group of frames, can be saved from the destructive criticism of M. Le Roux. But to this end the postulate of absorption of gravitation into the spatial frame must be abandoned; and the principle of equivalence of gravitation and acceleration would disappear. The application of the mathematical spatial analysis to astronomy and optics would be reconstructed as a dynamical theory of normal type, unfolding itself in terms of a distribution of Action located ultimately throughout the region of the problem: but the results as modified would still require actual confirmation. If, however, any gravitational influence on light is finally established by the astronomical observations, this type of analysis by aid of a varying spatial frame may remain the most effective way to include it in theory.

[1] Abstract of a paper read on January 22 at the Cambridge Philosophical Society.

The Nature of Gels.

By Dr. S. C. BRADFORD.

IT has been known, probably from the earliest times, that when sufficiently concentrated solutions of certain substances, such as gelatin and agar-agar, are allowed to cool, instead of depositing crystals of the dissolved substance, the whole liquid turns into a jelly. It is natural, therefore, that speculations on the nature of jellies should have been rife long before Graham, in 1861, first pointed out the slow rate of diffusion of colloid substances which distinguished them from bodies which separate from solution in the ordinary crystalline form.

The many theories of gel structure fall naturally under three heads: (1) One-phase or molecular systems, (2) two-phase liquid-liquid systems, and (3) two-phase liquid-solid systems. To the first class belongs Proctor's hypothesis that a gel is a more or less solid solution of a liquid in the colloid substance, in which both constituents are within the range of molecular attractions. This view is very similar to the "super-cooled liquid" theory of glass, and, like that, has difficulty in explaining the loss of mobility which occurs on setting. Proctor suggests that the transformation consists in the formation of tenuous crystals, which interlace and possibly anastomose. Later experiments[1] show that gelation is really an extreme case of crystallisation, but this suggestion would bring Proctor's theory into the third class. In either case, however, his experiments are important, as they show that the swelling of gelatin in

[1] Bradford, *Science Progress*, 1917, 12, 62; *Biochem. Jour.* 1918, 12, 357; 1920, 14, 91; 1921, 15, 553; and "The Physics and Chemistry of Colloids," Discussion by the Faraday Society, etc., London, 1921.

acids can be explained by simple chemical and physical laws.

To the second class belong both Hardy's and Wo. Ostwald's theories that gels are composed of two liquid phases. Theories of this type present the same difficulty as those of the first class in explaining the increase of viscosity during gelation. No emulsions are known having properties really like those of gels. Nor can liquid-liquid systems be imagined with the elastic properties of gels. Moreover, no hypothesis in either of these classes is sufficient to allow the deduction of the various properties of gels, and there is little direct evidence for any of these suppositions.

The third type of theory, that gels contain both liquid and solid, is the most natural, and was the earliest to be proposed. The first definite suggestion appears to have been made by M. L. Frankenheim in 1835, who thought that jellies were aggregates of small crystals with pores between them. A similar view was adopted in 1879 by K. von Nägeli, that such bodies were composed of molecular complexes, or micellæ, with crystalline properties, separated by skins of water and forming meshes (or interstices) in which the water was contained by molecular attraction. From the use of the German word *Maschen* it has been inferred that von Nägeli intended a geometrical framework. But it is not necessary to assume that he meant more than that the water was held by molecular attraction in the interstices of the aggregates (within and between), and that the aggregates were separated by capillary skins of water. This view is almost exactly that which must be accepted as the result of recent experiments. However, since von Nägeli, a number of unsuccessful attempts have been made to devise a mathematical network which would account for the elastic and thermal properties of jellies; it has scarcely been recognised that such a framework must conform to the facts that the elastic properties of different gels differ greatly, and that the different directive forces inherent in the ultimate particles of different jellies must have some effect on their structure. On this account it seems unlikely that a single framework would be found to satisfy the different properties of different gels; it appears more probable that the structure of gels will be found to vary according to the nature of the gel substance.

O. Bütschli's extensive researches on foams and gel structure are well known. He came to the opinion that the properties of gels might be explained on the basis of a honeycomb structure, in which the walls were permeable to liquids because of their extreme thinness, although they might be porous. To this it must be objected that the use of alcohol and tanning reagents to bring out the microstructure, adopted by Bütschli, and later by Moeller, is open to objection, as being likely to alter the structure of the gels or to modify the gelation process. Moreover, Zsigmondy and Bachmann have demonstrated, from the vapour pressure isotherms, that gels must contain fine pores with a radius of from 2·5 to 5 $\mu\mu$, some 300 times smaller than Bütschli's honeycombs. From microscopic work on soap curds and gels, these workers and McBain have favoured a fibrillar structure. This view has also been adopted by Moeller for gelatin, and is supported by Barratt from experiments on fibrinogen gels. For the soaps and fibrinogen there is direct microscopic evidence that fibrils can be formed by the cooling solutions, indicating that the ultramicroscopic structure of their gels may be fibrillar. In other cases a globulitic structure is indicated. Menz observed the development of submicrons in gelating 2 per cent. gelatin, which increased from 4, showing Brownian movement, in a square division of the field with a side of 9 μ, to 80 or 100, at rest, in the same area. Hardy describes the appearance of microscopic spherites of 10 μ in gels of 5-dimethylaminoanilo 3 : 4-diphenyl*cyclo*-pentene-1 : 2-dione, and Bachmann showed that the ultramicroscopic appearance of gelatin gels deprived of water is globulitic.

Thus there is much evidence for the liquid-solid type of theory. Nor is Debye and Scherrer's X-ray analysis sufficient to show that the ultimate particles of gels are not crystalline, because the radial elements of the spherites, in which form experiments show gelatin and agar-agar to be deposited from solution, cannot be composed of many layers of molecules, and it is doubtful whether such complex molecules could produce appreciable interference of monochromatic X-rays.

But none of the theories mentioned is sufficiently definite to permit the deduction of the properties of gels and the explanation of the reversible sol-gel transformation. Nor do they suggest a reason why such substances as gelatin and agar-agar should occur invariably in the colloid state. The latter question proves to be a crucial one. Investigation shows that, in this respect, there is no fundamental difference between gelatin and other substances—that the same laws govern their solution and precipitation; and gelation is merely a limiting case of crystallisation.

In this connexion the researches of von Weimarn are of fundamental importance. From a great many experiments with such substances as barium sulphate and aluminium hydroxide he deduced an empirical formula,

$$N = K\frac{P}{L},$$

which expresses a relation between N, the "form coefficient" of the precipitate, and K, P, and L, respectively functions of the viscosity of the reaction medium together with the size and structure of the particles in solution, the excess concentration of the substance to be precipitated, and its solubility. Von Weimarn was able to show that as N increases, the precipitate passes through stages in which it appears as (1) large complete crystals only after some years, (2) ordinary crystals in a short time, (3) growth figures or needles, (4) amorphous precipitates frequently showing microscopic spherical grains, and (5) as a gel which cannot be differentiated by the microscope. The formula suggests at once that gelation is merely an extreme case of crystallisation, and that gelatin is a substance the properties of which lead naturally to a high value of N. This is completely borne out by experiment. Not only do the properties of gelatin sols coincide with those of supersaturated solutions, but by reducing the value of N, gelatin is readily obtained as a precipitate, with particles microscopically visible. The solubility of ashless gelatin in water is found to be 0·12 grm. per 100 grm. solution at room temperature, *i.e.* about 18° C. More recently Fairbrother and Swan found the value 0·07 per cent. at 18° for another brand containing 2·24 per cent. of ash. Such a solution is perfectly clear. At 0·13 per cent. gelatin forms a metastable solution, which remains in the supersaturated stage on account of the very low diffusion constant of the substance. This solution has a beautiful bluish opalescence and may be regarded as a typical sol. A further slight increase in concentration brings about the precipitation of the excess of gelatin as a gelatinous mass appearing in the microscope like grains of sand. Many of the particles can be separately distinguished; they are spherical in form and up to about 2 μ in size. With increase of concentration, the bulk of the precipitate grows and the particles decrease in size until, at about 0·7 per cent., the precipitate fills the solution and forms a white, slightly opaque jelly. The opalescence gradually disappears as the gel particles become smaller with increasing concentration. Gelatin jelly is therefore a gelatinous precipitate of gelatin of at least 0·7 per cent. concentration.

The size of the particles can be increased by allowing them to grow by spontaneous evaporation of the solution, subject to the necessary precautions. After one month the precipitate is buff-coloured, and appears as a mass of perfectly spherical microscopic grains exactly like Perrin's grains of mastic. From these and many similar experiments, in conjunction with the ultramicroscopic appearance, it may be concluded that a gelatin jelly is a mass of ultramicroscopic spherites of gelatin in which, as von Nägeli suggested, the water is held by molecular forces. These forces are the cause of the swelling in water, and the heat of swelling can be calculated roughly on this supposition. The structure fits exactly Zsigmondy's analysis of the vapour pressure isotherms. Experiments on the relation between the excess concentration and the size of particle are being made and may lead to a more definite form of von Weimarn's equation. But, in its present state, the formula is sufficient to explain the occurrence of gelatin in the colloidal state. The molecular weight is unknown, but Dakin's recent analyses suggest that it may be as great as 10,000, or more, a value which would correspond to a molecular diameter of 0·75 $\mu\mu$ and bring its molecules up to colloidal size. But, though the molecular weight should be much less, there is no doubt that the molecules are very complex, for this is the reason for the very low diffusion constant; moreover, as the viscosity also of the sols is considerable, the factor K must be very large. In addition to this, the solubility, L, is very small, and the excess concentration, P, is usually large, so that everything conspires to produce a maximum value of N corresponding to the colloid condition. The permanence of the jelly is due to the very small diffusion constant, which prevents recrystallisation. But this does occur slowly, as is shown by the gradual appearance of opalescence, and even of microscopic spherites, in gels kept for a long time in sealed tubes.

Since agar-agar also separates from solution in the form of spherites, it appears that the structure of gels of this substance and of gelatin is probably that of a pile of shot, while soap and fibrinogen gels may be fibrillar. Such a fine-grained structure is compatible with all the known properties of gels, except the heat of swelling of gelatin, 5·7 cal. per grm., and the so-called thermal anomaly. Re-determination of the former gave 33·25 cal., and investigation of the latter showed that it was unfounded. Two questions remain undecided: (*a*) The nature of the spherites and (*b*) whether they are joined together to produce a framework in the jelly. Spherites are known in every gradation, from the obviously crystalline form, built up of coarse radiating crystalline needles separately visible, through stages showing only a more or less radiating formation, but giving the well-known shadow-cross in polarised light, to apparently homogeneous spherical bodies giving no definite evidence of crystalline structure. Gelatin and agar-agar spherites appear to belong to the last class. Experimental evidence suggests that the spherites coalesce during gelation. They would seem either to aggregate crystallographically or to adhere by their mutual attraction; or, the apparent attraction may be due to the water molecules having a greater mutual attraction than the spherites. It will be admitted, however, that, in the case of such small particles, there can be very little difference between the two former methods of attachment, since the union must be due to the forces between the few molecules in the surface of contact. With two grains only, the coupling would be unstable, but it would become firm as more grains were added.

Since writing the above, evidence has been obtained that the gelatin spherites are really crystalline. Some of these, grown to a size of about 3 μ, by methods previously described, and mounted in glycerin, were examined with polarised light. When the Nicols were crossed they became brilliantly coloured and many showed shadow crosses, while grains of mastic prepared by Perrin's method and mounted in the same way became invisible. These experiments are being continued, but, without evidence to the contrary, it will be difficult to deny that gelation is merely an extreme case of crystallisation.

Physical Properties of Clay and Clay-Mud.

MUD and clay are materials, the properties of which are not only of concern to the meticulous housewife and to the children who make mud pies and clay engines; the geologist has found interest in their formation, and from the study of them is able to trace a large part of the history of the earth's crust. They have played their part in the æsthetic development of the race. They have been the architect's and engineer's friend for the making of building materials, and have filled them with concern and not infrequently dismay when they have desired to build upon them or when they desired to support them. The story of the development of buildings, bridges, and other types of structures, tells of many failures, because of the treacherousness and uncertainty of these materials, and partly, at least, because engineers and architects had not attempted to determine their properties in a scientific manner.

Mr. A. S. E. Ackermann has presented, during recent years, four papers to the Society of Engineers in which he has described experiments to determine the physical properties of clay and the effect of water content upon their properties.[1] He has shown that, like certain metals, clays have a certain measure of fluidity. When a disc resting on clay is loaded the disc sinks into the clay, the amount it descends depending on the load and on the time allowed; and when the load exceeds a certain amount, which depends upon the amount of water present, the rate and extent of penetration are considerably increased. The stress at which this occurs, Mr. Ackermann has called the pressure of fluidity. Mr. Ackermann's experiments have been directed toward determining the bearing power of soils, and the loads that can safely be applied to them.

The difficulty of reconciling experimental data on the properties of these materials is evidenced by comparing the results of experimenters. Mr. Ackermann states that the friction angle for wet mud varies as the square root of the pressure, while Crosthwaite says it is proportional to the square root of the pressure. A special committee of the American Society of Civil Engineers to codify present practice on the bearing values of soils for foundations, has issued a series of reports, and has emphasised the importance of the colloid content of clay, which consists of non-crystalline, hydrated, gelatinous aluminium silicates, gelatinous silicic and hydrated ferric oxides; rarely aluminium hydrate may also be present. Most of the grains of the minerals in the clay are enveloped by colloid, but quartz grains

[1] Society of Engineers Transactions, 1919–20–21–22.

do not, as a rule, have the colloid coating. The plasticity of the clay depends upon the amount of colloid present. To separate the colloidal from the granular material, the clay is revolved at 40,000 revolutions per minute in a separator.

Dr. Hubert Chatley, in a recent paper,[2] has discussed the properties of clay-mud, and states that it has three special features :

(1) A granulated structure of varying degrees of fineness.

(2) A semi-permanent water content, which gives it peculiar mechanical properties.

(3) A certain small reserve of chemical potential, which, under certain conditions, will cause it to change in various ways.

He discusses the methods of observing the granular matter by means of the microscope, and states that the plasticity depends upon the size of the products and the proportion of colloids present. He divides the water content into three classes.

[2] Society of Engineers, June 1922.

Clay-mud containing 15 per cent. by weight of water has a tensile strength of 15 lb. per sq. inch, but doubling the water content reduces the tensile strength to one-third of this amount. With 28 per cent. of water, its viscosity is about the same as a heavy grease, corresponding to a shear strain of 1 radian per 100 seconds, under a shear stress of more than 100 grm. per sq. cm. It differs from heavy grease, however, in that water is extruded as the pressure is increased. It is not watertight, and dykes allow water to percolate very slowly, but if the surface of the dyke is dry, the surface tension may arrest the flow.

The results of the data indicate agreement with common experience that the water content of clay is of great importance, and they also indicate that, as with all other materials, the working stresses should be within the "elastic range."

Silvanus Thompson Memorial Lecture.

At the request of the Finsbury Technical College Old Students' Association, Sir Oliver Lodge gave the first of these lectures at the College on February 1, Sir Charles Parsons in the chair, to an audience numbering more than a thousand and including many eminent past students. After a reference to the splendid work of the College in the past, and its hopes for the future, the lecturer recalled the brilliant succession of teachers—Ayrton, Perry, Meldola—colleagues of Thompson. Of the latter he said : "The breadth of his outlook and width of his interests are almost proverbial ; his facility in foreign languages enabled him to hold his own in assemblies abroad, and he had a real artistic faculty. He had a love of discoveries in their nascent stages, and became a recognised historian of science. To a man of his cosmopolitan feelings and pacific disposition, the war and its atrocities were a great distress ; grief and worry and overwork overtook him, and he succumbed on June 12, 1916—a victim of the war—having been principal of Finsbury since 1885."

Proceeding to the subject of the lecture, "The Origins or Foundations of Wireless Communication," and confining himself to matters prior to 1896, Sir Oliver recalled that the term "inductance" did not at first exist ; Lord Kelvin introduced it as a mathematical coefficient, Maxwell spoke of self-induction, and Heaviside originated the term now used. In the early work on the production and detection of electric waves in the ether, Kelvin, Maxwell, FitzGerald, and Hertz laid the foundations which made the present superstructure possible.

In 1875 Edison observed the possibility of drawing sparks from insulated objects in the neighbourhood of an electrical discharge ; already in 1842, Henry, in Washington, had surmised through a similar observation—that there was some similarity between the etherial disturbance caused by the discharge of a conductor and the light emitted from an ordinary high-temperature source. Early in the 'eighties David Hughes, working with the microphone and galvanometer, got something like a coherer, but was discouraged from pursuing the matter. In 1865 Maxwell gave the theory of electric waves, before their generation or detection was understood ; he showed that they would travel with the velocity of light, that light was an electromagnetic phenomenon, that conductors of electricity must be opaque to light, and that the refractive index of a substance was intimately related to its dielectric coefficient.

This discovery aroused great enthusiasm, and one result was to influence the lecturer to devote his life to the study of electric waves ; he discussed them with Fleming and FitzGerald, and spoke about them at the British Association in 1879 and later. In 1883 FitzGerald proposed the generation of the waves by using the oscillatory discharge of a Leyden jar, and the lecturer, in 1887, produced and detected them. The waves were received on wires adjusted to the right length for resonance. The experiments of Hertz, who received the waves on a nearly closed ring of wire having a short spark gap, were reported by FitzGerald at the British Association meeting of 1888, and Sir Oliver calculated the horse-power of the oscillator—about 100, for a millionth of a second ; he exhibited many of the effects of the waves at the Royal Institution in 1889, but there was nothing akin to signalling ; that was foreshadowed, in 1892, together with the possibility of tuning, by Sir William Crookes, who spoke of wave-lengths with which to signal to specific people, and alluded to Hughes's signals made from room to room without intervening wire.

In 1890 Sir Oliver employed a form of coherer to complete a bell circuit, and in 1893 heard of Branly's filings-coherer. In memory of Hertz, for whom Sir Oliver expressed the greatest admiration, both on account of his experimental skill and mathematical thoroughness, he gave a lecture at the Royal Institution on the work of Hertz ; at this lecture actual signalling with a coherer was demonstrated. This work led to the grant of Lodge's patent in the United States, which was the fundamental patent of the American Marconi Company. The lecture stimulated Dr. Muirhead, Captain (now Admiral Sir Henry) Jackson, Admiral Popoff, Prof. Righi, and others to their experimental successes ; in 1896 Mr. Marconi came to this country—and the rest is common knowledge.

After the lecture the audience was entertained at a conversazione in the laboratories. A beautiful collection of Dr. Thompson's paintings was on view, together with a number of his works, including a translation of Gilbert's "De Magnete" (1601) and a copy of the original. Coils constructed by Faraday, the first Nicol prism, a coherer made by Sir Oliver Lodge, acoustical and optical models, and many personal relics were lent by the late Doctor's family. Mr. W. M. Mordey, president of the Old Students' Association of the College, gave a demonstration of some effects of alternating magnetism on iron, nickel, cobalt, and ores of these metals, and on Heusler alloy. Prof. E. G. Coker showed the action of cutting tools working on a transparent medium by means of polarised light, using for this purpose Dr. Thompson's large Nicol prism, and Prof. C. H. Desch exhibited a number of lantern slides illustrating the structure of steel and non-ferrous alloys. Dr. Eccles, principal of the College, and a number of past students had interesting exhibits.

Pasteur.

ON Friday last, February 2, an address on the work and ideals of Pasteur was given in the rooms of the Royal Society by Dr. Pasteur Vallery-Radot, the grandson of Louis Pasteur. This was the first of a series of lectures, organised by the Alliance Française to be given by Dr. Pasteur Vallery-Radot in this country, in commemoration of the centenary of Pasteur, which is being celebrated this year. Sir Charles Sherrington, president of the Royal Society, was in the chair, and among those present at the meeting were Sir Anthony Bowlby, Sir Humphry Rolleston, Sir William Hale-White, Sir Charles Ballance, Prof. C. J. Martin, and Mr. Chaston Chapman.

Dr. Pasteur Vallery-Radot prefaced his remarks by saying how much he appreciated the homage which this country was paying to his illustrious grandfather, since it was in England, the home of Jenner and Lister, that Pasteur found some of his most ardent supporters. He contrasted the state of medicine before the advent of Pasteur with what it was at the end of the nineteenth century, showing what immense benefits had accrued to humanity at large from the brilliant researches of this great man.

In the short period of forty years, Pasteur lifted the study of infectious disease out of the morass of empiricism and placed it on a scientific basis. By his discoveries he opened up a new world, the realm of micro-organisms, and laid the foundations of bacteriology, which to-day occupies so important a position in medicine and many industries. The numerous investigations of Pasteur, commencing with his work on the tartrates and paratartrates at the age of twenty-six, were next rapidly passed in review. His fundamental discoveries in fermentation, his investigations on the disease of silkworms, chicken cholera, swine erysipelas, anthrax, these were all dealt with in logical sequence leading up to the masterpiece of this scientific genius, anti-rabies inoculation.

Perhaps to many this story was not new. It bears repetition, however, not only because of its enthralling interest, but because of the lesson which can be learnt from it. There are many, even to-day, who are only too ready to point the finger of scorn at scientific investigation or to oppose animal experiments. If only these misguided individuals were to make a study of the life and work of Pasteur, perhaps many of the grotesque criticisms of research would remain unuttered. To what did Pasteur owe his great success? We are told that as a youth at the Lycée he showed no promise of great achievement in life, that he was no more than an average pupil. He was, however, endowed with an imagination which served him well in planning his investigations. Coupled with this gift was a critical faculty which he applied rigorously to all he did—an unusual combination. It was, however, his faith in the experimental method, his fundamental honesty, his single-mindedness and his immense desire to advance knowledge and work for the good of humanity, which enabled Pasteur to achieve what he did. Inspired by this ideal, he went from one success to another, carrying all before him. Despite this, Pasteur remained simple and unostentatious to the end; he was indeed a great man.

Pasteur and Lister are perhaps the two most beautiful characters among the scientific men of the last century. Their lives should be read and studied by all those entering upon a career of scientific investigation. With such a model as Pasteur and fired by some of the idealism and enthusiasm of this great man, even those of mediocre attainments would achieve success.

S. P. B.

University and Educational Intelligence.

CAMBRIDGE.—Another important development of the Agricultural School of the University is foreshadowed in an offer from the Ministry of Agriculture and Fisheries announced by the Council of the Senate. In the first instance the offer is of a sum of 30,000*l*. from the Development Commissioners to provide for a Chair of Animal Pathology. On the professor being appointed, he would be required to prepare a scheme for the development within the University of the study of the diseases of farm animals. For an approved scheme the Commissioners would be prepared to find a capital sum of about 25,000*l*. for buildings, the sites to be provided by the University. While the Corn Production Acts (Repeal) Act Fund lasts, *i.e.* till about 1927, annually recurring grants for maintenance and research would be met out of that Fund. After the Corn Repeal monies come to an end the Ministry confidently expect to find from other sources money to continue the work. In the event then of the necessary financial provision not being forthcoming, the University would be under no obligation to continue the Institute. Both the Schools of Agriculture and of Medicine stand to gain greatly from this new scheme, and work of the utmost importance for that side of agriculture which depends on live-stock will be initiated.

It is proposed to confer the degree of M.A., *honoris causa*, on Mr. Humphry Gilbert-Carter, director of the Botanic Garden.

LONDON.—A course of four public lectures on "Electric Fields in Atomic Physics" will be given at University College, at 5.15 on March 13, 15, 20, and 22, by Prof. E. T. Whittaker. Admission will be free, without ticket.

Applications are invited by the Senate for the University readership in cultural anthropology tenable at University College. The latest time for the receipt of applications (12 copies) is the first post of Thursday, February 22. They should be sent to the Academic Registrar, University of London, South Kensington, S.W.7.

OXFORD.—An examination will be held at Keble College on March 13 for two science scholarships, each of the annual value of 80*l*., plus 20*l*. laboratory fees. The subjects of the examination will be chemistry or biology, with elementary physics, and, for biologists, elementary chemistry in addition. Information can be obtained from Dr. Hatchett Jackson, Keble College, Oxford.

Dr. R. A. Peters, lecturer in biochemistry in the University of Cambridge, has been elected to the Whiteley professorship of biochemistry.

DR. G. H. CARPENTER, professor of zoology at the Royal College of Science, Dublin, has been appointed keeper of the Manchester Museum.

DR. RAFFAELE ISSEL, son of the late Prof. Arturo Issel, the geologist, has been appointed professor of zoology in the University of Genoa.

IN the course of the annual dinner of the Honourable Society of Cymmrodorion on January 19, at which the Prince of Wales was the chief guest, Mr. Dan Radcliffe promised, in honour of His Royal Highness, to give 50,000*l.* for the benefit of the University of Wales.

THE Sydney correspondent of the *Chemical Trade Journal* writes that the secretary of the Victorian Chamber of Manufactures has informed the registrar of the University of Melbourne that the sum of 1500*l.* per annum for ten years has been contributed for the University funds "for the purpose of assisting in providing and maintaining professional chairs associated with arts and sciences which have relation to industries and production."

IN connexion with Battersea Polytechnic, Tate scholarships in engineering, science, and domestic science are being offered for competition in June next. The scholarships vary in value from 20*l.* to 30*l.* per annum, with free tuition, and are tenable for two or three years. The latest day for the receipt of applications is April 21. Further particulars are obtainable from the principal.

"THE continued neglect of science as a part of general education in schools" is lamented by the advisory committee on the textile industries and colour chemistry departments of the University of Leeds in a report for the year 1921–22. They are able, nevertheless, to congratulate these departments on being permeated as never before by the spirit of research. An illustrated account of one of their investigations—into the ancestry of the Suffolk Down sheep—appeared early last year in NATURE (vol. 109, p. 595). The number of students, though smaller than in the preceding year, was still large: day students 277, evening 131. More than 80 per cent. of students who completed their course in the department of colour chemistry and dyeing last session obtained either positions in factories or research scholarships; there is evidence of an increasing tendency for large manufacturing firms to engage only those students of the department who have obtained in addition to the honours degree some experience of research in pure science.

A USEFUL "Record of Educational Publications" is issued from time to time by the United States Bureau of Education. Those of May and September 1922 (Bulletins 21 and 33, 5 cents each) covering a period of about 8 months, contain some 800 titles of books and articles classified under such headings as: educational history, current educational conditions, educational theory and practice, educational psychology, psychological tests, etc. In many cases a brief synopsis of the contents is given. Eleven books and pamphlets, containing 1300 pages, and 50 magazine articles are devoted to the subject of intelligence tests, interest in which was greatly stimulated in America by their utilisation during the war for recruiting purposes. Under the heading of higher education appear notices of two works by French "exchange" professors, one being "Universities and Scientific Life in the United States" (Oxford University Press), by M. Caullery, who was exchange professor of biology at Harvard, and one, "Six mois à l'université Yale," by A. Feuillerat, which appeared in the *Revue des deux Mondes* for February and March 1922. *School Life* announces that seven American universities have combined to finance an exchange between Prof. Jacques Cavalier of Toulouse and Prof. A. E. Kennedy of Harvard and the Massachusetts Institute of Technology.

Societies and Academies.

LONDON.

Royal Society, February 1.—O. W. **Richardson**: The magnitude of the gyromagnetic ratio. The gyromagnetic ratio has the value m/e instead of 2m/e, the value calculated on the turning electron orbit theory of magnetism of the Langevin type; the discrepancy may be due to the rotation of the atomic nucleus. In iron it appears that the effective electron orbits possess altogether two quanta of angular momentum per atom and the nucleus a single quantum of angular momentum on this view.—Sir Richard **Paget**: The production of artificial vowel sounds. Plasticene resonators were used to imitate resonances heard by the writer in his own voice when breathing various English sounds. The first models, made in rough imitation of the oral cavity, gave two double resonances. The models were tuned by appropriate alterations of form until they gave recognisable breathed vowel sounds when blown through a small orifice at the back. An artificial larynx was made by means of a rubber strip laid edgewise across a flattened tube, and, when blown through this larynx, the models gave recognisable voiced vowels. The oral cavity behaves in every case as two Helmholtz resonators in series, and the remaining vowel sounds were reproduced by forming two separate resonators joined together in series, and made of such capacity and size of orifices as to allow for mutual reaction of resonators on their respective resonant pitch. Vowels may be produced by two resonators in series with a larynx between them, and a single tubular resonator may act as two resonators in series. Two resonators in parallel, blown by means of a single larynx with a bifurcated passage, produced vowel sounds indistinguishable from resonators in series.—F. **Simeon**: The carbon arc spectrum in the extreme ultra-violet. The arc-spectrum of carbon gives lines in the Lyman region at 1194, 945, 858, 687, 651, 640, 599, and 595, which have not been previously observed. They correspond with prominent lines in the "hot-spark" spectrum studied by Millikan. Groups of lines have been found at 1657, 1560, 1335, 1329, 1260, 1194, 1175, 1036, and 651, of which those at 1329, 1260, 1194, 1036, and 651 do not seem to have been observed by any other worker, and that at 1657 has not been completely resolved heretofore.—J. **Joly**: Pleochroic haloes of various geological ages.—H. A. **Wilson**: The motion of electrons in gases.—H. **Hartridge**: The coincidence method for the wave-length measurement of absorption bands. Measurements of the absorption bands of pigments by the ordinary spectroscope are inaccurate because of the breadth of the bands and the indefiniteness of their margins. The adjustment of two similar absorption bands into coincidence can be effected with considerable accuracy. If then a spectroscope is designed in which two spectra are seen side by side on looking down the eyepiece, but reversed in direction with one another, the measurement of the mean wave-length of the absorption bands can be accurately carried out. The quantitative estimation of pigments depends on the movement of the bands which occurs when the concentration of one pigment changes. In measuring the percentage saturation of blood with carbon monoxide from the wave-length of the *a*-absorption band, the accuracy of measurement is approximately 0·7 Å.U. The probable error in setting two absorption bands into coincidence is little greater than that of setting two sharp black lines into coincidence, or of making one line bisect the area between two others.—A. **Berry** and Lorna M. **Swain**: On the steady motion of a cylinder through infinite viscous fluid. The so-called "inertia" terms are neglected and a solution is found which satisfies the boundary conditions on the cylinder and makes the velocity only logarithmically infinite in one direction at infinity. The relative velocity increases comparatively slowly with the distance from the cylinder, and the solution should give a fairly good approximation to the motion at small distances from the cylinder. First, the elliptic cylinder is treated as a limiting case of the ellipsoid. The solution, which in the case of the ellipsoid satisfies the boundary conditions and those at infinity, leads to a solution for the elliptic cylinder. The plane laminæ, both along and perpendicular to the stream, are considered as limiting cases, and further, the motion due to the circular cylinder is deduced as a special case of the elliptic cylinder. Secondly, the solutions for the elliptic and circular cylinders are obtained directly from the equations of motion. Finally, stream-lines, curves showing variation of velocity along stream-lines and curves of constant velocity are drawn for three limiting cases.—W. **Jevons**: The line spectrum of chlorine in the ultra-violet (Region λ 3354-2070 Å.). Observations of the spectrum of the chlorine discharge tube, which have not hitherto extended lower than λ 3276 Å. (Eder and Valenta), have been continued so far as λ 2070 Å. by means of 10-feet grating and quartz-prism spectrographs. Wave-lengths and wave-numbers of nearly 200 newly observed Cl lines are recorded, together with the effects of variations of capacity on the intensities of more than 100. The constant differences ($\Delta\nu$) 40·4, 67·1, 107·5, found by Paulson in pairs and triplets above λ 3276 Å. recur in a few pairs below that point. The significance of these separations in relation to the analysis of the spectrum, however, appears doubtful, since there is no apparent regularity in the intensities of the lines involved, and no triplets having these separations have been detected in the region under investigation.—M. H. **Evans** and H. J. **George**: Note on the adsorption of gases by solids and the thickness of the adsorbed layer. The amount of carbon dioxide adsorbed by unit surface of glass, at a pressure approximating to one-sixth of an atmosphere, suggests that the carbon dioxide is condensed on the surface of the glass in a liquid layer having a thickness equal to between five and six times the diameter of the molecule of the gas. By combining this result with the published figures of Mülfarth (*Ann. d. Physik*, 1900, vol. 3, p. 328) on the relative adsorption by glass of the gases acetylene, nitrous oxide, carbon dioxide, sulphur dioxide, and ammonia, it is found that these gases are adsorbed by the surface to such an extent that if they were present as liquid layers, the thickness of the layers would vary from (in the case of acetylene) three, to (in the case of ammonia) forty molecular diameters. A direct determination of the degree of adsorption of ammonia gives a value of the same order as that calculated from Mülfarth's data. The results are in disagreement with Langmuir's recent generalisation that the forces of attraction exerted by a surface do not extend to a distance greater than the diameter of one molecule.

Linnean Society, January 18.—Dr. A. Smith Woodward, president, in the chair.—G. H. **Wilkins**: (1) A dried vegetable mass made from a variety of wild plants, Chenopodium and others. The plants are now important in the food-supply of the Russian peasantry; they are dried, pounded to a fine flour, and mixed with rye to make coarse cakes. (2) The Shackleton-Rowett expedition in the *Quest* to the Antarctic Regions. On St. Paul's Rocks no plants save a few Algæ were found, but at South Georgia, an island about 100 miles long and 20 miles broad, a considerable collection was made, and reindeer thrive. Lichens and mosses only were observed on Elephant Island; at Tristan da Cunha 16 species were gathered.—E. G. **Baker**: The flora of Gough Island; 20 flowering plants and 10 ferns are known. The only small trees on the island are Phylica and Sophora. There is a new species of Apium allied to *A. australe* Thouars, but having broad cuneiform segments to the leaves. The widely-spread fern *Lomaria Boryana* Willd. reaches a height of from 2 to 3 feet.—Miss Helena **Bandulska**: The cuticular structure of certain dicotyledonous and coniferous leaves from the Middle Eocene flora of Bournemouth. Three new species of dicotyledonous leaves are described from their cuticular structure. The name Dicotylophyllum is proposed for such leaves of uncertain affinity. The cuticles of some fossil conifers were compared with known recent and fossil forms. Thus *Araucarites Göpperti* Sternberg, *Taxodium europæum* Sap. and *Sequoia Tournalii* Sap. are considered on the evidence of cuticular structure to be specifically distinct.

Aristotelian Society, January 29.—Prof. A. N. Whitehead, president, in the chair.—Rev. Leslie J. **Walker**: A new theory of matter. The general trend of scientific thought seems to indicate a return to the basic principles of the Aristotelian philosophy, a philosophy in which the concept of energy is no less fundamental than it is in modern scientific theory. On the other hand, the atomic theory, the electron theory, and still more especially the quantum theory, would seem to indicate that we shall sooner or later be forced to give up the notion of an infinitely divisible continuum, and to substitute in its place a continuum composed of definite and indivisible units. There was, prior to Aristotle, a theory which treated the continuum as a structure composed of unit-magnitudes in immediate relation or "contact" one with the other. It is possible to develop this theory on Aristotelian lines, taking as the basic assumption that the characteristic of ether-particles is to be in immediate relation with six and only six other particles, and that the characteristic of mass-centres is that they may be in immediate relation with either more or fewer than six other particles, possibly with four as a minimum and eight as a maximum. The primary type of change would thus be a change in the immediate relation of particles one to another, and the primary law governing such change an ever-increasing approximation towards equal distribution of the ether-particles with respect to the mass-centres. The theory gave rise to several features analogous to those which are of primary importance in the electron theory.

Edinburgh.

Royal Society, January 8.—Lord Salvesen in the chair.—J. S. **Dunkerly**: Encystation and reserve food formation in *Trinema lineare*. The paper showed that the process of conjugation and encystment in the rhizopod, *Trinema lineare*, is followed by nuclear fusion, and the formation of reserve food material in the cyst is apparently due to the activity of the extra-nuclear chromidial mass.—Lancelot **Hogben**: Photo-micrographs were shown illustrating a new technique for removal of the pituitary gland in frogs and toads; also photo-micrographs of changes in melanophore response incident to partial and total extirpation of the gland.

Sheffield.

Society of Glass Technology, January 17.—Prof. W. E. S. Turner, president, in the chair.—W. H. **Hatfield**: Stainless steel, with some consideration of its application to the glass industry. Stainless steel can now be made direct into castings, into sheet steel which is very malleable—a development of the last two years—and into tubes, so fine that hypodermic needles are now largely made from stainless tubes. Stainless steel contains 12-14 per cent. of chromium. The carbon content varies a little with the different types but is generally about 0·30 per cent. Stainless steels could be made use of in the glass industry on account of their resistance to scaling and strength at high temperatures. Stainless steel has a high tensile strength, a high fatigue range, and can be hardened and tempered. It might be utilised for parison and blow moulds; many parts of feeder devices might be usefully produced in such material, and also blowing irons, rolls, belt conveyors, lehr chain pins, and other things, including knives for cutting viscous glass. The ends of blowpipes might also be made of stainless steel as well as wire brushes. Stainless steel is being used for mirrors for scientific purposes.—S. **English**: Some measurements of the viscosity of glasses near their annealing points and a critical review of some recent literature on the annealing of glass. Strain in glass cannot always be detected by using polarised light; the most sensitive position is that in which the direction of the strain in the glass is at 45° to the plane of polarisation. The selenite plate is more sensitive than plain crossed nicols only when a very poor source of light is used; it is not possible to distinguish between tension and compression stresses by the use of such a plate. The rate of change of mobility of glasses at their annealing points is approximately constant, most requiring a rise of temperature of 9° to cause a doubling of the mobility. In some cases this temperature interval rises to 11°. At 100°-150° above the annealing points the temperature interval required to double the mobility was generally rather longer than that required at the annealing points. The mobility of glasses is not a logarithmic function of the temperature. The working properties of lead glasses and other soft glasses are probably determined more by the rate of radiation of heat than by rate of change of viscosity with temperature.

Paris.

Academy of Sciences, January 15.—M. Albin Haller in the chair.—The president announced the death of M. van de Sande Bakhuyzen, corresponding member for the section of astronomy.—L. **Lindet** and P. **Nottin**: The evolution of the starch grains in the tuber of the potato.—W. **Kilian** and F. **Blanchet**: The ammonites collected by the *Pourquoi-Pas?* Emmanuel de Margerie was elected corresponding member for the section of mineralogy in the place of the late M. Œhlert.—Martin **Alander**: Integral functions which have all their zeros on a straight line.—G. **Sagnac**: The periodic variable spectrum of double stars: the incompatibility of the observed phenomena with the theory of general relativity.—J. **Haag**: The problem of *n*-bodies in the theory of relativity.—Edouard and Rémy **Urbain**: The separation of liquid mixtures by combined distillation and atmolysis. The preparation of practically pure ethyl alcohol and nitric acid. The alcohol is boiled in a flask fitted with a porous tube as reflux condenser. Round this tube is an outer glass tube in which the pressure is reduced. More water than alcohol vapour diffuses through the porous tube, and the alcohol in the flask can be strengthened to 99·8 per cent.—Ch. **Bedel**: A polymer of hydrocyanic acid. The crude polymerisation product of hydrocyanic acid is extracted with ether, and the brown crystals deposited by this solution purified by solution in hot water and treatment with animal charcoal. Its composition is $(HCN)_4$ and appears to be aminopropanedenitrile hydrocyanide.—Alfred **Schoep**: Parsonite, a new radioactive mineral. This is found associated with chalcolite from the Belgian Congo; and has the composition $2PbO.UO_3.P_2O_5.H_2O$. It is radioactive.—Mlle. Germaine **Cousin**: The prolongation between Belfort and Thann of the tectonic accidents of the secondary border situated to the south of the Vosges *massif*.—Ch. **Dufour**: Values of the magnetic elements at the station of Val-Joyeux (Seine-et-Oise) on January 1, 1923.—Odon **de Buen** and José **Giral**: The hydrographic tables of Knüdsen, normal water and the limits of error in the analysis of sea water.—Louis **Besson**: The loss of light in Paris and its neighbourhood. Curves are given showing the proportion of light received at nine observing stations as a function of the direction of the prevailing wind.—G. **Mangenot**: The starch of the red Algæ.—A. **de Puymaly**: New mode of cell division in the Desmidaceæ.—Emile **Haas**: New experiments on the phenomenon of Broca and Sulzer (fatigue undulation).—A. **Goris** and A. **Liot**: The importance of organic ammoniacal salts in the production of pyocyanine by the pyocyanic bacillus.—J. P. **Averseng**, L. **Jaloustre**, and E. **Maurin**: Some effects of thorium-X on diastases and micro-organisms. Thorium-X clearly increases the activity of the hydrolysing or oxidising properties of the enzymes studied (pyalin, amylase from pancreatic juice, amylase from germinated barley, emulsion, ammonia ferment, oxydases of the blood and saliva), and also increases the vitality of certain pathogenic organisms.—Georges **Bourgignon** and Henri **Laugier**: Variations of the neuromuscular excitability under the influence of the suppression and re-establishment of the circulation of a limb in man.

Washington.

National Academy of Sciences (Proc. vol. 8. No. 12, December 1922).—O. **Veblen**.—Projective and affine geometry of paths.—W. F. **Hamilton**: A direct method of testing colour vision in lower animals. Two Hilger wave-length spectrometers used as monochromatic illuminators were arranged to throw beams of light on the opposite ends of a horizontal glass tubular cell containing Drosophila which had been kept in the dark overnight. The intensities of the beams (of different wave-lengths) were regulated so that the flies showed no orientation. One beam was then screened for a time, and on again exposing it, the flies definitely moved towards it showing differential fatigue. The smallest difference of wave-lengths showing a stimulating effect was used, and over the range 385-500 $m\mu$, hue-perception is a maximum between 410 $m\mu$ and 450 $m\mu$, possibly indicating two receptor systems, one for the blue-violet and one for the blue-green.—L. L. **Nettleton**: Characteristics of a short wave oscillator at very low pressures. A three-element tube was left permanently connected with the vacuum pumps, and currents up to 300 milliamps. at 700 volts were used. The oscillations were measured by a crossed wire thermocouple carried on a bridge sliding along the Lecher wires. Oscillations of wave-length 50-200 cm. were obtained. Both negative plate current and oscillations ceased abruptly at very low pressures (0·00005 mm.) in the tube as measured by an ionisation manometer. The curves resulting from plotting the voltage at the plate and the oscillations in the Lecher wires against the ionisation appear to show that some little ionisation is necessary for this type of oscillation, but the kind of gas present does not seem important.—Bergen **Davis** and H. M. **Terrill**. The refraction of X-rays in calcite. A water-cooled tube with a molybdenum target was used and measurements were made for the first three orders of the $K\alpha_1$

line. The results correspond to a shift of the first order line of 5", so for this wave-length, the effect of refraction is slight. P. W. Bridgman.—The compressibility of metals at high pressures. The pressure range was 12,000 kgrm./cm.^{2}, and measurements were made at 30° and 75°. The compressibility of every metal decreases with rising pressure and, generally, increases with rising temperature; the order of magnitude of the change is the same for all the metals. Germanium and uranium are possible exceptions. Metals crystallising in a cubic form show the same compressibility in all directions, but the compressibility of, *e.g.*, zinc, measured in three directions perpendicular to each other, varied in the order, roughly, of 1 : 3 : 4. Tellurium shows a negative effect in one direction. The results accord with a theory of two interpenetrating lattices as the structural basis of most metals. There appears to be no simple repulsive potential relation between the atoms of metals which will account for the compressibility data.—Raymond Pearl and L. J. Reed: A further note on the mathematical theory of population growth.

Official Publications Received.

Annual Report of the Meteorological Committee to the Air Council, for the Year ended 31st March 1922. (M.O. 257.) Pp. 59. (London: H.M. Stationery Office.) 2s. net

Ministry of Finance, Egypt: Coastguards and Fisheries Service. Report on the Fisheries of Egypt for the Year 1921. By G. W. Paget. Pp. vi+78. (Cairo: Government Publications Office.) P.T.5.

Catalogue of the British Industries Fair, The White City, Shepherds Bush, London, W.12, February 19–March 2, 1923. Pp. xxxii+256+130. (London: Board of Trade.) 1s.

Air Ministry: Meteorological Office, London. Southport Auxiliary Observatory (The Fernley Observatory of the Corporation of Southport). Annual Report, and Results of Meteorological Observations, for the Year 1921; with an Appendix containing Monthly Averages, for 10 years, of the Amount and Duration of Rainfall under Different Wind Directions. By Joseph Baxendell. Pp. 36. (Southport: Fernley Observatory; London: Meteorological Office.)

Diary of Societies.

MONDAY, FEBRUARY 12.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Surg. Comdr. R. J. M'Keown and Surg. Comdr. A. Gaskell: The co-operation between the Members of the profession and the medical services of the armed forces in peace and during war.—Discussion: Air Commodore D. Munro, Major-General C. E. Pollock, and others.

ROYAL SOCIETY OF ARTS, at 8.—Dr. H. P. Stevens: The Vulcanisation of Rubber (Cantor Lectures) (2).

SURVEYORS' INSTITUTION, at 8.—C. P. Sanger: The Law of Property Act, 1922.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H. St. J. B. Philby: The North Arabian Desert.—Major A. L. Holt: The Future of the Desert.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. E. F. Buzzard and others: Discussion on Psycho-Therapeutics.

TUESDAY, FEBRUARY 13.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. C. Pearson: Greek Civilisation and To-day (1): The Beginnings of Science.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Prof. A. J. Clark: The Scientific Basis of Non-Specific Protein Therapy.—Dr. H. Blumgart: The Treatment of Diabetes Insipidus by Intra-Nasal Spraying of Pituitary Extract.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.—G. W. E. Gibson: Some Practical Notes on Oil Pumping.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Miss Ella Freeman Sharpe: The Super-sensitive Child at School. A Psycho-Analytic Study.

INSTITUTE OF TRANSPORT (at Institution of Electrical Engineers), at 6.—B. Wagenrieder: Railway Rules and Regulations.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—T. D. Madsen: Internal Combustion and Economy.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—A. E. Bawtree: Dangers to Eyesight in Domestic Electric Lighting and the Kinema Picture Display.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—D. T. Scourfield: Presidential Address.

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at London School of Economics), at 8.—F. Mott: Practical Hints on Buying and Selling. (To be followed by a Discussion.)

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. K. Wilson: Involuntary Laughing and Crying.

WEDNESDAY, FEBRUARY 14.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—Sir John Bland-Sutton: Hunterian Oration.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-section of Proctology), at 5.30.—P. Lockhart-Mummery: New Method of treating Ischio-Rectal and other Abscesses.

INSTITUTION OF AUTOMOBILE ENGINEERS, at 7.30.—J. L. Chaloner: High-speed Oil Engines.

ASSOCIATION OF ENGINEERS-IN-CHARGE (at St. Bride's Institute), at 7.30.—C. H. J. Day: Hydraulic and Electric Lifts.

ROYAL SOCIETY OF ARTS, at 8.—W. J. Rees: Progress in the Manufacture of Refractories.

THURSDAY, FEBRUARY 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. B. Melvill Jones: Recent Experiments in Aerial Surveying (1).

ROYAL SOCIETY, at 4.30.—E. R. Speyer: Researches upon the Larch Chermes (*Cnaphalodes strobilobius*, Kalt) and their bearing upon the Evolution of the Chermesinæ in general.—G. V. Anrep: The Irradiation of conditioned Reflexes.—M. Dixon and H. E. Tunnicliffe: The Oxidation of reduced Glutathione and other Sulphydryl Compounds.—J. C. Bramwell, R. J. S. M'Dowall, and B. A. M'Swiney: The Variation of Arterial Elasticity with Blood Pressure in Man.—L. J. Harris: The Existence of an undiscovered Sulphur Grouping in the Protein Molecule. Part I. The Denaturation of Proteins. Part II. The Estimation of Cystine in certain Proteins.—N. B. Laughton: Reflex Contractions of the Cruralis Muscle in the Decerebrate and Spinal Frog.

LINNEAN SOCIETY OF LONDON, at 5.—A. M. Altson: On the Method of Oviposition and the Egg of the Beetle *Lyctus brunneus*, Steph.—R. Paulson: Arctic Lichens from Spitsbergen.—F. H. Lancum: Strange Behaviour of a Female Butterfly, *Colias edusa*.—Canon Bullock-Webster: Exhibition of Thirty Varieties of *Chara hispida*.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Wing-Commdr. T. R. Cave-Brown-Cave: The Practical Aspects of the Seaplane.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Richardson: M. Coué and his Work.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. Rosen: Some Problems in High-speed Alternators and their Solution.

CHEMICAL SOCIETY, at 8.—A. Chaston Chapman: Spinacene, its Oxidation and Decomposition.—R. H. Pickard and H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XIX. The Rotatory and Refractive Dispersion of *d*-γ-nonyl nitrite.—H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XX. The Rotatory Dispersive Powers of Oxygen Compounds containing the Secondary Octyl Radicle.

CAMERA CLUB, at 8.15.—Major F. C. B. Laws: Progress in Aerial Photography.

FRIDAY, FEBRUARY 16.

GEOLOGICAL SOCIETY OF LONDON, at 3.—Annual General Meeting.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—J. T. Marten: The Indian Census, 1921.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—G. J. Jenkins: Preliminary communication on Osteitis Deformans and Otosclerosis.

INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—H. C. Young: Some Mechanical Problems in the Rubber Industry.

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 7.30.—H. T. F. Rhodes: Chemical Inspection as it is and as it should be.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—T. L. Allison: Notes on some Insulating Materials.

EUGENICS EDUCATION SOCIETY (at Prince's Restaurant), at 7.30.—Prof. Pigou: The Economic Importance of Eugenics.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Prof. Philippson: High-frequency Currents applied to the Study of Cellular Physiology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. V. Hill: Muscular Exercise.

SATURDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (1).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: Household Appliances of a Hundred Years Ago.

TUESDAY, FEBRUARY 13.

GRESHAM COLLEGE, at 6.—Sir Frederick Bridge: Music. (Succeeding Lectures on February 14, 15, and 16.)

WEDNESDAY, FEBRUARY 14.

UNIVERSITY COLLEGE, at 5.—P. Leon: The Theory of Beauty. (Succeeding Lectures on February 21, 28, March 7, 14, and 21.)

KING'S COLLEGE, at 5.30.—Dr. D. H. Scott: The Succession of Floras in the Past.

FRIDAY, FEBRUARY 16.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. Graham Wallas: The Competition of the Sexes for Employment (Stansfeld Lecture).

UNIVERSITY COLLEGE, at 5.15.—P. A. Scholes: The Place of Music in the Education of the Future.

KING'S COLLEGE, at 5.30.—Dr. E. W. Scripture: Shakespeare's Verse in the Light of Experimental Phonetics.

SATURDAY, FEBRUARY 17.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. F. A. Bather: A Limestone Cliff and the Animals that built it.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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The Social Influence of Science.

SOME controversy has taken place lately as to the part played by science in promoting social progress, and an American book appeared in the autumn specially contesting any such claim. The argument is difficult to follow. To those who take a broad view of history it seems obvious that the growing stability of societies, the wider organisation of all kinds of human activities, the quicker transport and closer communication between nations, are all due mainly to the spread of science. To those who look critically at details it seems doubtful whether our societies are really stable, whether life is now happier or nobler than it was in less scientific days, whether the evils and destruction wrought by modern instruments do not outweigh the undoubted advantages that science has brought.

Our judgment in this great debate will be dictated largely by our temperament. The critical, the melancholy, the disappointed will be inclined to think that the rush, the complexity, the vastness of the modern world have brought more evils than they have removed. The young and vigorous, those who enjoy life and hope for its continuance, will take another view, and these, with the improvement in health which still goes on and the increase in prosperity which was continuous until the war, form a large normal majority. The current depression of spirits, which is not perhaps so widespread as is commonly supposed, is due partly to a reaction against the exaggerated optimism of the Victorian age, partly to the troubles due to the war. It ought to be possible to put aside these disturbing influences and take a broad calm view of social progress. In any such survey the influence of science in recent centuries is necessarily a leading feature.

Now the first condition of such a review is to make it wide enough. The processes of life develop by minute changes, and when a violent change does occur, it has to be readjusted and equilibrium set up again by counterbalancing changes. Hence it would be a gross distortion of the truth to judge—and condemn—the industrial revolution by comparing peaceful rural England with the horrors of the early years of the factory system. The latter were new and unforeseen facts which called for special remedial measures. It is equally absurd at the present day to declare modern civilisation bankrupt because the German financial system has broken down and no one has yet seen how to re-establish international trade and credit. These things are momentary, unexpected shocks: the world has passed through far worse storms in its time and we shall weather the less as we have the greater. A sound judgment can be based only on a wide view, and in a matter so vast as social progress affected by science, the view should be as extensive as the subject itself.

People have lately been using the term "science" in a looser and more comprehensive sense than heretofore. Its roots might be found in the practical skill, the mother-wit and sharp senses of the primitive savage. In any case the beginnings may be seen in the settled communities of the great river-valleys, in Egypt, Babylonia, the Yangtze, as well as in Mexico and Crete. Can one doubt that the science involved in the drawing up of the first calendars by the priests of Egypt and in the marvellous structure of the pyramids was a factor of the first importance in preserving the social order and cohesion of those early theocracies, the first great permanent aggregations of mankind upon the planet? The power of prediction involved in science, and first exemplified in the making of the calendar, was intimately bound up with the power of securing obedience, and the acceptance of their lot by the millions who worshipped the Pharaoh.

The Greeks were, of course, the founders of science in the stricter sense, which seeks the law of change, the principle of unity in the manifold; and it might be thought that the constant disunion of ancient Greece disproved the social or unifying effect of science. But this would be to take a narrow and short-sighted view. Greek science had from the first a strong social value. It formed a link between the early philosophers in the Ionian cities of its birth, and in the case of the Pythagoreans it was the basis of a brotherhood which aimed as much, or more, at social reformation than it did at increasing the scope of abstract thought. In fact all the early Greek philosophers were also interested in social and political problems. They saw that true wisdom was a practical thing, fit to inspire, as Anaxagoras said, "a calm religion free from fear."

But the chief moral and social effect of Greek science came later, first, when Hellenism was spread over the Middle East by the arms of Alexander, secondly, when, in the Greco-Roman world, Greek science and Roman law combined to lay the foundation for the medieval and modern world. The younger Pliny, when proconsul in Asia Minor under Trajan, gives an interesting illustration. He points to the effect of astronomy in allaying the fears and composing the minds of the mass of the people.

In estimating the social influence of science, however, the mind turns naturally to its greatest expansion in the last few centuries. When in the sixteenth century the mind of Ancient Greece awoke again and men began to seek in Nature herself for the answer to the problems of life, there were two new factors in the world which affected the results of their inquiries. One was the discovery of new lands, the expansion of the West. The other was the decay of slavery, the recognition of manual and mechanical work as a worthy occupation of good brains. This the Greeks had never recognised, and their failure limited the application of science to industry in ancient times. But with the advent of a New World and a new spirit in industry, from the sixteenth century onwards, the transformation of society by science went on apace. From the middle of the eighteenth century it has become apparent as the dominating force in the world.

Hence the question of the intrinsic value and the social influence of science is primarily a discussion of the effects of the Industrial Revolution in which we still live. The fact that we are living in it now and making it more complete every moment, adds enormously to the difficulty of valuation. It is a part of ourselves and influences almost every act and thought, and therefore to deplore and condemn the tendency, or to wish it away as Ruskin did, is futile in practice and pessimistic in philosophy.

Two or three main points stand out clear in the contemporary picture. They are, in the first place, facts with which the student of social life has to concern himself to understand the movement; and, in the second place, guides to action, indicating the line which those must take who are pressing for the stability and betterment of society.

The world is one in a new—if you will, an artificial—sense, due to the application of science to transport and communications of all kinds. This process is being accelerated by every possible means and is pre-eminently a social one. It must find its issue in complete international trade and a really comprehensive League of Nations, acting as the organ of common interests and opinion. It is most important to remember that the League of Nations, which we already possess, is the fruit of the historical evolution due to science and was only precipitated and not caused by the war. The unification of the whole world is only the result on a large scale of a process which has knit up every particular society in a closer organisation than before. Science, being itself a social product, due to the intercourse of active minds, finds its expression in a social organisation impossible without the application of science. This is seen not only in the organisation of industry but also in every activity of the community from the government downwards. All are closer and more complicated, just in proportion to the extent that the given society has created, imbibed, and applied the results of scientific thinking. Expressed briefly and broadly, but with perfect truth, humanity is the counterpart of science, the practical obverse of the abstract reverse of thought.

To make this process more effective by conscious effort is therefore the supreme task of those concerned in social progress at the present time. The growth has hitherto been mainly automatic. We have to understand it, grasp it, and turn it to the still greater good of mankind. Science having made the modern world, with all its strength and its weaknesses, let men of science inspire a social will into the whole community, to use this master-instrument for its highest end, the salvation and elevation of the humanity to which it belongs.

F. S. Marvin.

Phantasms of the Living.

Proceedings of the Society for Psychical Research. Vol. 33, Part 86, October. (London: F. Edwards; Glasgow: MacLehose, Jackson and Co., 1922.) 16*s*. 6*d*. net.

A book entitled "Phantasms of the Living," by Edmund Gurney, F. W. H. Myers, and Frank Podmore, was published in 1886. Under this title were included all experiences where there was reason to suppose that the mind of one living person had affected the mind of another otherwise than through the recognised channels of sense. The chief aim of this book was to produce a cumulative quasi-statistical proof of telepathy.

In the thirty-six years which have elapsed since the publication of this book the Society for Psychical Research has received and published in its Journal many accounts of happenings similar to those recorded by Gurney, and in its Proceedings of October last Mrs. Henry Sidgwick has submitted the best of these cases to a careful examination and analysis.

While Gurney and his collaborators were chiefly concerned to prove telepathy to be a fact of Nature, Mrs. Sidgwick thinks we have arrived at a stage when, if our knowledge of telepathy is to grow, we must seek light on its process and the conditions under which evidence of it can be obtained. She says: "We may now, for the sake of argument at least, assume that Gurney's book has accomplished its object, and that telepathy is proved, and starting from that point may devote ourselves primarily to seeking for light on the occasions and mode of its operation." Mrs. Sidgwick does not mean to imply that telepathy is yet accepted by the scientific world; but she thinks something more than the mere piling up of facts is required, and that "our facts will be the more readily accepted, the more we can compare them, and, provisionally assuming telepathy, show when and how it occurs."

Many of the best cases received by the Society during the past thirty-six years have already been published in various works on psychical research, and fifty-four have appeared in the Proceedings of the Society for Psychical Research. All these, being therefore already before the public, are excluded from this collection. The cases included have appeared only in the Journal of the Society, which is printed for private circulation among members. The value of the present collection is considerably diminished by the exclusion of so many cases which were of course selected for earlier publication, because they were regarded as being specially important or interesting. Even without these, however, we have here some two hundred cases, many of which are important as affording evidence that telepathy does occur, and all of which help to throw some light on the occasions and mode of its operations.

The broad lines of classification adopted in the description of telepathic phenomena may be gathered from the headings of the four chapters into which Mrs. Sidgwick's volume is divided: (1) Experimental and semi-experimental cases; (2) Spontaneous cases in which the percipient's impression is not externalised; (3) Spontaneous cases in which the percipient's impression is externalised as a waking hallucination; also dreams of the same character; (4) Collective and reciprocal cases without evidence of any agency external to the percipient.

In all modern records of telepathic experiences the person whose mind receives the impression is called the percipient, and the person from whose mind the impression comes is called the agent; but it would appear from the evidence that the percipient is very often the "active" party, and that the so-called agent plays a purely passive part. This is seen in the semi-experimental cases in which a percipient is trying to get an impression from another person who is quite unaware that any such attempt is being made. In experimental cases, properly so-called, the agent is deliberately trying to impress telepathically a particular percipient, and that percipient is deliberately trying to receive an impression. It is doubtful, however, what part, if any, the concentrated effort of the agent plays in the success of such experiments.

The experimental and semi-experimental cases recorded in this collection can scarcely be regarded as representative of the group because of the number excluded, owing to their having been already published; but even had these been included there would still have been occasion for Mrs. Sidgwick's comment that "more experiments carefully conducted and well recorded are greatly needed."

Of spontaneous cases in which the percipient's impression is not externalised as a hallucination, Mrs. Sidgwick says: "As a whole the class is not a strong one as evidence of telepathy," because the triviality or vagueness of the impression in many cases makes tricks of memory very likely to occur. Of more importance as providing evidence of the occurrence of telepathy are the spontaneous cases in which the percipient's impression is externalised as a waking hallucination. The first case recorded under this heading (p. 152) is one of the most striking in the whole collection. It is one of the many cases of "death coincidences" which form an important part of the evidence for telepathy. (Apparitions or other hallucinatory experiences occurring within twelve hours of the death, before or after it, are classed as phantasms of the living.) The apparition in this case was that of an officer of the Royal Air Force, who was killed in a flying accident on December 7, 1918, and the percipient was a fellow-officer who spoke of his experience to another person before it was realised that it was not the living man who had appeared.

Another interesting case in this section is a dream experience, first recorded in the *Times* of July 21, 1904, by Mr. Rider Haggard, the percipient (p. 219). The dream was to the effect that a favourite retriever dog was lying on its side among brushwood, or rough growth of some sort, by water. The recorder says: "In my vision the dog was trying to speak to me in words, and, failing, transmitted to my mind in an undefined fashion the knowledge that he was dying." Investigation showed that the dog had been killed by a passing train, and had fallen into a stream where reeds grew, at or about the time of the dream experience. The case is well authenticated, and all the circumstances point to the improbability that "mere coincidence" is the true explanation. Another striking case is one reported by Sir George Beilby (p. 243), in which a percipient had a visual hallucination of her brother in Australia at a time when he had fallen into unconsciousness which lasted until his death some days later.

"Collective and reciprocal cases" are dealt with by Mrs. Sidgwick in her final chapter. These are cases in which "two or more persons have at the same time spontaneous psychical experiences—either hallucinations or dreams—which seem to be related to one another, but where no evidence of any agency outside the two percipients exists." When the percipients were in the same room we must consider the possibility that one percipient may have influenced the other through the senses (suggestion), but where the percipients were in different rooms or in different houses, the relation of the one hallucinatory or dream experience to the other can scarcely be accounted for in this way. Here either chance or telepathy must be invoked.

In concluding her examination of this collection of phantasms of the living, Mrs. Sidgwick describes two cases of reciprocal dreams, in both of which the dreamers were in separate houses, and in both of which the reciprocality seems to have been very complete. Reciprocal cases are rare, and the small number recorded hitherto has raised some doubts as to the genuineness of the type; but Mrs. Sidgwick thinks they are very important as throwing light on the whole process of telepathic communication. She says: "I think the kind of union of minds, the thinking and feeling together, here shown, may be regarded as the type or norm of telepathic communication to which all other cases conform in varying degrees." This implies a merging together of minds, a "transfusion" of thought rather than a transmission or transference. We have the physical analogy of "contact" in place of "transmission-through-space."

It can scarcely be maintained that the cases here passed in review afford by themselves very strong proof of the occurrence of telepathy, but taken in conjunction with the body of evidence brought forward by Gurney, and the many well-attested cases published in the Proceedings of the Society for Psychical Research and elsewhere, they help to strengthen the conviction, to which many competent observers have been forced, that these accounts of apparent action of mind upon mind in the absence of any physical medium of communication, bring to our notice some fact of Nature which students of science can no longer ignore.

The most obvious, and perhaps the most serious defect in the evidence for telepathy afforded by these cases is the long interval which so frequently elapsed between the experience and the recording of it. In only 11 out of 191 tabulated cases was the record made on the day of the experience, and 4 of these were semi-experimental cases, in which one might have supposed immediate record to have been a necessary part of the experiment. In 15 instances the record was made "next day." In most of the cases the interval extended for months or years, but all cases in which it exceeded five years are omitted from this collection.

After all that has been written about the importance of immediate record and attestation of any presumably super-normal experience, it is astonishing that those who are subject to such experiences should so often neglect this elementary rule. T. W. MITCHELL.

The Synthetic Colour Industry.

The Manufacture of Dyes. By Dr. John Cannell Cain. Pp. ix+274. (London: Macmillan and Co., Ltd., 1922.) 12*s.* 6*d.* net.

THE author of this treatise, which is published posthumously, was one of a small band of British chemists, who long before the war placed their services at the disposal of the home industry in synthetic dyes. But, largely owing to lack of appreciation of the value of scientific knowledge on the part of manufacturers, the result in almost all cases was disillusionment and disappointment, so that this group of trained investigators, including Dr. Cain, were compelled by force of adverse circumstances to transfer their activities to other branches of chemical enterprise. In 1915, however, the Government became aware somewhat tardily of our national deficiencies in regard to the manufacture of dyewares, and Dr. Cain was appointed a member of the technical committee of British Dyes, Limited, afterwards holding the position of chief chemist in the newly erected Dalton works of this firm. His experiences in these two phases of the English colour trade, extending over twenty-five years, are embodied in the manual under review.

It is obvious that in a handbook of some 260 pages all the important colouring matters cannot be included, and among the notable omissions are such well-known synthetic dyes as the Hessian purples, formyl violet, rhodamine S, the acridine yellows, and the first representatives of the anthraquinone vat dyes, namely, indanthrene blue and yellow. Nevertheless, a judicious and typical selection has been made, and the author has given full working details wherever he has possessed first-hand practical knowledge of the factory operations.

This impress of realism is especially noticeable in the informative chapters on azo and triphenylmethane dyes; for in both these branches of colour production Dr. Cain ranked as an expert. As, however, this work will be read by students, it is perhaps permissible to point out that the somewhat unnecessary rubrics at the beginnings of the chapters on monoazo and disazo dyes do not tally with the arrangement adopted in the text. Fast red B contains two naphthalene nuclei, although classed as a mixed benzene-naphthalene dye, and diamond black F, placed in the purely naphthalenoid section, contains a benzene nucleus, and there are several other similar discrepancies in classification. In a future edition these headings might with advantage be omitted.

In spite of the apathy prevailing before the war in this branch of chemical industry, British chemists had developed a sound technique in the manufacture of certain standard dyes such as magentas, aniline blues, and safranines. The manual contains useful information in regard to these intricate preparations. On the theoretical side it will be noticed that the author has not adopted the prevailing view that the oxazines, thiazines, and azines are ortho-quinonoid derivatives. The future may show that this conservatism is well grounded.

The two closing sections of the book present a marked contrast. The penultimate chapter on anthraquinone and allied colours is, with two exceptions, already noted, detailed and comprehensive; the last chapter on indigoid colours is an unfinished fragment constituting a sad reminder of the sudden and premature close of an active life devoted to the theory and practice of colour chemistry.

To the student of organic chemistry this work offers a concise introduction to the fascinating though complex subject of synthetic dyes. To the expert colour-maker or user it supplies a full bibliography with copious references and an adequate index. Both classes of readers will find the book to be an excellent supplement to the author's earlier volume on the manufacture of intermediates. G. T. M.

Rea's "British Basidiomycetæ."

British Basidiomycetæ: A Handbook to the larger British Fungi. By Carleton Rea. (Published under the auspices of the British Mycological Society.) Pp. xii + 799. (Cambridge: At the University Press, 1922.) 30s. net.

EVERY mycologist will welcome the appearance of this volume, which is issued under the auspices of the British Mycological Society and represents thirty years of careful and continuous field-work on the part of its author. The author, whose skill in distinguishing our fleshy agarics one from another has been freely placed at the disposal of so many students of fungi in this country, is to be congratulated heartily upon having crowned his life's labours with the publication of a work at once so comprehensive and so valuable for reference.

Massee's "British Fungus-Flora" appeared in the years 1892–1895. In the interval some hundreds of Basidiomycetæ, either new or new to Britain, have been discovered in this country—many of them by Mr. Rea himself—and descriptions of all these species are included in the present volume. In accuracy of description the book is an immense advance on anything previously produced in Britain.

There are a number of commendable features in the work: (1) Every species is numbered, Rea's last number being 2546; (2) the species actually seen are indicated by the letters *v.v.* (*vidi vivum*); (3) in the description of species the essential characters are placed in italics; and (4) the derivation and meaning of the name of each genus and species is given, philology thus illuminating mycology.

The classification adopted is based chiefly on the well-considered system set forth by Patouillard in his

"Essai taxonomique" (1900), and it therefore differs in many important features from that of Massee, which was based on the work of Fries. It is new to British mycologists, and will doubtless puzzle somewhat many of the older workers; but it represents an important attempt to incorporate in a systematic treatise the anatomical and microscopical data which various investigators have brought to light during the last half-century.

In the classification adopted by Fries, Berkeley, Massee, and others, the main divisions of the Agaricineæ were based on spore-colour. We were thus at the outset provided with Leucosporæ, Rhodosporæ, Ochrosporæ, Porphyosporæ, and Melanosporæ; but in the present volume these groups have disappeared and spore-colour has become a character of relatively minor importance. In Rea's classification, the Agaricales are divided into (1) the Agaricineæ, containing the bulk of the lamellate fungi in one sub-order Agaricaceæ; (2) the Cantharellineæ; and (3) the Boletineæ, the last named including Paxillus and Boletus. The divisions of the Agaricaceæ are based first on the nature of the receptacle, then on the presence or absence of a ring, etc.; and it is only the final distinctions, separating the genera from one another, which for the most part are based on spore-colour. No doubt this new classification has its advantages; but some of its defects are sufficiently obvious. Thus, while Anellaria differs from Panæolus in little more than the possession of a membranous, often fugacious, ring, we find that Anellaria is placed close to Lepiota and Panæolus close to Collybia. For Fries, the genus Panæolus included the species subsequently placed by Karsten in Anellaria. The reviewer cannot but feel with Fries that the species of Panæolus and Anellaria are closely related to one another and that these genera should not be so widely separated.

The writer is inclined to doubt whether spore-colour is only of such minor importance as is now supposed. There is every reason to believe that the genus Coprinus, with its parallel- or subparallel-sided gills and the ripening and discharge of its spores from below upwards on each gill, followed by autodigestion of the gills from below upwards, is monophyletic. Now the spores in this genus are all black or blackish fuscous. In it there are no species with white spores or spores that are pink, purple, ochraceous, or ferruginous. Yet in the genus there are species with rings, *e.g. Coprinus comatus*, and without rings, *e.g. C. picaceus*; species with fairly thick flesh, *e.g. C. atramentarius*, and species with membranous flesh, *e.g. C. plicatilis*; species with dimorphic basidia and species with quadrimorphic basidia; species with large and numerous cystidia and species without cystidia; species which live exclusively on dung and species which live exclusively on wood, etc.; yet, while the genus Coprinus was evolving, the colour of its spores remained constant. It is evident that, in the genus Coprinus, spore-colour is a more fundamental character than ring-formation. If this is so with Coprinus, it may well be the same with other genera of Agaricineæ. Rea's system of classification, although in some of its details it does not satisfy the writer, has the advantage that it will stir up thought and thus make for further progress.

"British Basidiomycetæ" is distinctly Mr. Rea's own book; and, in writing it, he has adopted as regards species a somewhat conservative and independent attitude. Thus he includes descriptions of certain species which are now known to be identical with others—*e.g. Coprinus oblectus*, which is undoubtedly identical with *C. sterquilinus*, and *Coprinus radians*, which is generally considered as identical with *C. domesticus*. His independence is further shown by the fact that in certain groups he has adopted his own views rather than those of his fellow-workers in this country. Thus, in treating of the Clavariæ, he has not followed entirely the revision of the British Clavariæ as given by Cotton; while, in some instances, in treating of the Thelephoreæ, he has accepted American views rather than those of Miss Wakefield.

The volume is indispensable to all students of fungi on both sides of the Atlantic; for it is only by a clear understanding of the first-described European species that New World plants can be correctly named. The task of describing two thousand five hundred Basidiomycetæ is no mean one; and botanists generally, as well as mycologists, are under a deep debt of gratitude to Rea, not merely for having accomplished it, but for having accomplished it so well.

A. H. REGINALD BULLER.

An Index to Periodical Literature.

(1) *The Subject Index to Periodicals.* Issued by the Library Association. K: Science and Technology. Pp. 555. (London: Library Association, Stapley House, 1922.) 35*s*. net.

(2) *The Subject Index to Periodicals, 1920.* Issued by the Library Association. A: Theology and Philosophy (including Folk-Lore). Pp. 98. (London: Library Association, Stapley House, 1922.) 6*s*. net.

WE congratulate the Library Association on this welcome addition (1) to the valuable subject indexes to periodicals which it has already published. The present index contains the titles of 15,000 papers, published during the years 1917–19, obtained from the examination of 400 periodicals. It would appear that more than half the papers indexed are in the English language, having been published in the British Empire or in the United States. The language next in evidence is French.

The period covered—the second half of the war and the following year—was not very fruitful in scientific research, except in regard to subjects bearing upon the great conflict, but it is clear, both from the number of entries and from the number of journals consulted, that the index does not claim to be a complete record of all scientific and technical papers published during that period, but that a selection has been made. It would add to the value of these publications if the editors could see their way to include a list of the periodicals indexed in each section of these indexes when it is published. The inclusion of the name of a journal in such a list would not, of course, mean that all the papers printed in that journal had been indexed, but the omission of any journal from the list would definitely warn the reader that no papers in that journal had been included, and thus leave him to look up that journal if he thought it likely to contain papers on the subject of his study. It would also save the reader who wished to make a more exhaustive study of any subject from referring to journals which had been already examined. This is the plan followed in the lists of journals at the end of each volume of the "International Catalogue of Scientific Literature." In the present case, a list of the titles of the 400 journals examined would probably take up no more than three or four pages.

The usefulness of these indexes depends entirely upon a wise choice of the headings under which the titles are grouped. It may be assumed that the Library Association is partly guided in its choice of headings by experience of the inquiries made by readers asking for books.

The various headings are not arranged in any systematic way, and are not even divided according to the several sciences, but they follow one another in alphabetical order. The difficulty of this plan is that, when using such an index, it is not always possible to guess what heading will be chosen for a particular subject. This difficulty is, to a great extent, overcome in these subject indexes of the Library Association by the addition of numerous cross-references. Thus, under the heading "Refrigeration" we find a cross-reference to "Cooling Gases" indexed under "C." We might, however, not be so fortunate had we begun by looking up the subject of cooling gases under the heading "Gas." No doubt, the majority of those who use these indexes find a simple alphabetical arrangement of subjects more easy to understand than any systematic plan, and for that reason its use is justified.

In the preparation of this Index special attention has been paid to applied science and technology. Among headings which have a large number of entries of titles of papers are aeronautics; alloys; artillery; automobiles; coal; electric apparatus, power, heating and lighting; electroplating; fish and fishing; gas and oil engines; glass; iron; metals; mines; petroleum; photography; ships and shipbuilding; soils; wireless signalling.

(2) We are glad to find that the Library Association is continuing the publication of these subject indexes in other departments. Thus it has just issued a subject index for theology and philosophy (including folklore), indexing the literature of these subjects published in 1920, and occupying about ninety-six pages. This index contains titles of papers on psychology and psycho-analysis, as well as on philosophy and religion, and will therefore be of use to students of these subjects.

Our Bookshelf.

(1) *Boiler Plant Testing: a Criticism of the Present Boiler Testing Codes and Suggestions for an Improved International Code.* By D. Brownlie. Pp. xi + 168. (London: Chapman and Hall, Ltd., 1922.) 10*s.* 6*d.* net.

(2) *Steam Power Plant Auxiliaries and Accessories.* By Terrell Croft. Pp. xv + 447. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 15*s.* net.

(1) Mr. Brownlie has done great service in recent years in directing attention to uneconomical methods of steam production, and he has backed his criticisms by copious results of tests. The present volume contains an appeal for more rational methods of boiler testing, and criticises several existing codes, including that of the Institution of Civil Engineers. "A general impression also, on reading through the 'Civils'' code, is that boiler plant testing is an extremely complicated and difficult operation, which involves a knowledge of chemistry and mathematics quite beyond the ordinary engineer, and can only be carried out by the University graduate." Mr. Brownlie shows that boiler testing must be regarded as a thoroughly practical proposition which is necessary for the strictly utilitarian purpose of saving money. His criticism is constructive in that he gives full directions for carrying out practical tests, and includes a typical set of report sheets, with figures showing the results. The book is a distinct contribution to the subject, and it is to be hoped will lead to an early discussion and revision of the present codes.

(2) Considerable attention has been given recently to the formerly neglected auxiliary appliances connected with steam production. Pumps, feed-water heaters, fuel-economisers, condensers, steam pipes and traps are now taken seriously by the majority of engineers, and this consideration has led to the reduction of wasted heat. The engineer will find a great deal of useful information in this volume, which is of the nature of a joint effort on the part of a number of concerns and individuals. The matter included is not only serviceable for the purposes of the design and

arrangement of auxiliaries, but also conveys much useful information regarding their working and maintenance in practice. The subject is treated very thoroughly, and contains much that could only be found otherwise by searching through periodicals and the transactions of engineering societies.

Heat. By W. J. R. Calvert. Pp. viii+336. (London: Edward Arnold and Co., 1922.) 6*s*.

IT is sometimes difficult to justify the publication of a new text-book on a branch of elementary science, but Mr. Calvert has been so successful in presenting the subject of heat in an attractive and yet scientific manner that his book deserves a special word of commendation. The first part is intended to cover the ground of a general school education, and the second part brings the work up to University scholarship standard. The author realises that the majority of those who begin the subject will have little or no interest in experimental determinations unless it is made clear to them, at the outset, that objectives which appear to them reasonable cannot be reached without dealing with such measurements. He quotes with approval an appropriate sentence from one of J. B. Biot's works—"Toutes ces choses ne peuvent se déterminer sûrement que par des mesures précises que nous chercherons plus tard; mais auparavant il fallait au moins sentir le besoin de les chercher."

While practical applications have been emphasised, attention has been kept fixed upon the underlying principles. In all the experimental work the degree of accuracy likely to be attained has been carefully considered. In this connexion mention may be made of the details and dimensions which have been given in the case of many experiments of the laboratory or lecture type. We think the author is to be congratulated on having had the courage, even in so elementary a book, to give references to original papers. The few readers who look them up will gain a great deal, and even those who do not will at least be able to use the dates to get some idea of the chronological development of the subject. The book is the work of a teacher who has given much thought to the treatment of a familiar subject, and the result of his labours forms a valuable addition to the elementary literature of an important branch of physics.

(1) *Guide to the University Botanic Garden, Cambridge.* By H. Gilbert-Carter. Pp. xvi+117+24 plates. (Cambridge: At the University Press, 1922.) 3*s*. 6*d*. net.

(2) *An Alpine ABC and List of Easy Rock Plants.* Arranged by A. Methuen. Pp. x+35. (London: Methuen and Co. Ltd., 1922.) 1*s*. 6*d*. net.

(1) IN this attractive little handbook is a systematically arranged account of a number of the more interesting flowering plants which are cultivated in the University of Cambridge Botanic Garden, which should be of service to students in the Botany School of the University. The sequence is the familiar modern German one, and under each family is a short description of some of the genera and species which are regarded as specially worthy of mention. The plates, which are good full-page photographic reproductions, add to the value and attractiveness of the book. A clear plan of the garden indicating the larger plants with page-references to the trees, and an index of the genera and species mentioned in the book, enables the student to make full use of it. In deference to the oriental scholars who have loved and befriended the garden, the author has included the eastern names of some of the plants, with quotations illustrating the use of these names. A historical note gives the date of the foundation of the Cambridge Garden as 1762, and in 1831 the removal to the present site was authorised.

(2) Mr. Methuen's notes are for the beginner and the amateur. Their purpose is to give a list of the most attractive and the most easily grown Alpine flowers and to guide in their placing and cultivation. A few general rules are given for making a rock garden and planting and tending Alpines. The greater part of the book is an alphabetical list of the species recommended, with indication of the colour of the flower and very brief notes on cultivation. The book is the outcome of the compiler's own experience and conveys a good deal of useful information in a very small space.

The Origin and Development of the Nervous System: from a Physiological Viewpoint. By Prof. C. M. Child. (The University of Chicago Science Series.) Pp. xvii+296. (Chicago: The University of Chicago Press; London: The Cambridge University Press, 1921.) Price 1.75 dollars net.

IN the preface to his book, Prof. Manning Child points out that, considered from a physiological viewpoint, the origin of the nervous system must be sought in conditions present before the appearance of a morphological nervous structure. In accordance with this, the earlier chapters are devoted to a discussion of the origin and nature of the pattern which constitutes the organism as a whole, and to a consideration of the experimental investigation of some of the physiological conditions which antedate the appearance of the nervous system. A brief summary is given of the evidence for the existence of physiological axial gradients—*i.e.* graded differences in the organism in the rate of the fundamental activities of protoplasm and in the conditions associated with these activities—as the essential factors in the organismic pattern. An attempt is made to show that the nervous system is the physiological and morphological expression of the excitation-transmission relations, first with respect to the primary physiological gradients, and later with respect to the progressive developmental complications as they arise.

Prof. Child admits that with many of his points only suggestion, inference, or weighing of probability is at present possible. For this reason, and on account of the necessary technical detail, the book is more suitable for the biologist and physiologist than, as suggested in the note on the University of Chicago Science Series, to which this volume belongs, for the educated layman.

The Life of the Weevil. By J. Henri Fabre. Translated by Alexander Teixeira de Mattos. Pp. viii+278. (London: Hodder and Stoughton, Ltd., 1922.) 8*s*. 6*d*. net.

GATHERED together in this volume are the various essays on weevils contained in the "Souvenirs entomologiques" of Fabre. Chapters i. and vi.-ix. have already appeared wholly or in part in a previous translation, as have also chapter v. and parts of chapters vi.

and xii. They are, however, retranslated by permission of the publishers for the purpose of the present collected edition of English translations of Fabre's entomological writings. There is no doubt that the rendering of the latter into English will do something towards arousing interest in the phenomena of insect behaviour. We may even be permitted to express the pious hope that it will tempt the collector to turn aside from the mere acquisition of specimens and to observe the living more than the dead insect. The great family of the Curculionidæ, with more than 20,000 described species of weevils, provides a rich store of material for observation. Some of the most interesting features in the life-habits of these insects are discussed in the pages before us. Although lacking in the dramatic incidents so inseparably associated with the Hymenoptera, the behaviour of weevils as told of Fabre, and reproduced in this translation, will provide entertainment both to the general reader and the entomologist. A. D. I.

Modern Microscopy: a Handbook for Beginners and Students. By M. I. Cross and Martin J. Cole. Fifth edition, revised and rearranged by Herbert F. Angus. Pp. x+315. (London: Baillière, Tindall and Cox, 1922.) 10*s.* 6*d.* net.

That there has been a call for a fifth edition of this book we can well understand, as it gives an excellent introduction to all branches of microscopy. In the opening chapters the mechanics and optics of the microscope are described, and instructions are given on the general method of using the instrument, illumination, drawing and measuring apparatus, and for tests of the optical system.

In the second portion of the book, chapters written by specialists in their respective subjects deal with various aspects of microscopy. Thus, Mr. Barnard and Drs. Cooke and Drew describe the use of the microscope in medicine, including dark ground illumination; histology is dealt with by Mr. Cole, including hardening and embedding tissues and section cutting; and Prof. Cheshire writes on the microscope in geology and discusses simply and clearly the polarisation of light. Another interesting chapter is that by Mr. Cutler on the microscope in agriculture, particularly the protozoa of the soil. Pond life, foraminifera, mycetozoa, mosses and liverworts are some of the other subjects dealt with, and a final chapter by Mr. Cole describes the preparation and mounting of common objects. A useful glossary of technical terms is included, together with details of the Royal Microscopical Society's standards, the specifications of the British Science Guild, and microscopical societies and clubs. The book is very readable and well illustrated, and the information contained in it is accurate and up-to-date.

The Wirral Peninsula: an Outline Regional Survey. By W. Hewitt. Pp. x+293. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1922.) 7*s.* 6*d.* net.

Mr. Hewitt has selected a small and well-defined area, and in successive chapters has considered its physical, biological, and human aspects, in an endeavour to explain the geographical evolution of the area. The social and economic conditions of any region must necessarily depend to a large extent on its position, natural features, soil, climate, and vegetation. Wirral is only some 130 square miles in extent and until the middle of the nineteenth century was almost entirely agricultural. But the rapid increase of manufacturing industries across the Mersey and growing commercial importance of the Mersey estuary have resulted in an industrial invasion of the left bank of the river. Industries promise to show a steady increase in importance. Agriculture will probably retain its hold, but considerable changes in methods and conditions are taking place. The social evolution which Wirral is now undergoing can be adequately understood only by a study of its regional geography in the light of the past.

The volume is an example of the growing attention that is being paid to regional survey, and is a welcome addition to the small number of studies of this kind which have been prepared in this country. We gather that the author regards it as a preliminary sketch, and that a fuller survey is in course of preparation.

An Experiment in Synthetic Education. By Emily C. Wilson. With Chart for Five Years' Work. Pp. 62. (London: George Allen and Unwin, Ltd., 1921.) 4*s.* 6*d.* net.

More than one hundred years ago, Herbart sketched out his ideal system of education, which was to utilise all knowledge for the formation of character. For this purpose the knowledge was to be presented as a unity instead of in the usual way which drew a hard and fast line between each subject. Since his day the specialisation of knowledge has increased so much that the problem, difficult though it was then, is infinitely more difficult now; the intelligent teacher who would put his children into touch with all aspects of modern knowledge, while yet giving the requisite historical background for the understanding of that knowledge, is faced with difficulties at every stage.

This little book shows how one school attempted to deal with the problem. Each subject for convenience demands a name standing for particular aspects of knowledge, but it should be treated in relation to the other subjects. A chart giving details of a five years' scheme is appended. It is an interesting and suggestive experiment.

Leçons sur les Invariants Intégraux: Cours professé à la Faculté des Sciences de Paris. Par Prof. E. Cartan. Pp. x+210. (Paris: A. Hermann et Fils, 1922.) 20 francs.

An account of Poincaré's theory of integral invariants with special reference to analytical dynamics is given in the volume under notice. It opens with Hamilton's principle of least action and contains detailed discussions of such questions as differential systems admitting infinitesimal transformations. There are also chapters on the application of Poincaré's theory to the problem of *n* bodies and to Fermat's principle in optics. Much matter collected here can only be found scattered elsewhere in scientific journals.

Rayonnement et gravitation. Par Félix Michaud. Pp. viii+62. (Paris: Gauthier-Villars et Cie, 1922.) 6 francs.

An attempt which does not go into details to trace all physical phenomena back to radiation, gravitation for example being ascribed to ultra X-rays.

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.*]

On the Element of Atomic Number 72.

DANS le numéro du 20 janvier 1923 de NATURE, MM. Coster et Hevesy annoncent qu'ils ont obtenu le spectre de haute fréquence de l'élément de nombre atomique 72.

Ce résultat très important marque un progrès dans la question que nous avons ouverte (A. Dauvillier, *Comptes rendus*, t. 174, p. 1347, mai 1922 ; G. Urbain, *Comptes rendus*, t. 174, p. 1349) ; il est seulement regrettable que MM. Coster et Hevesy se soient efforcé de jeter le discrédit sur nos propres résultats.

Il nous paraît d'abord nécessaire de préciser les faits :

Deux raies [1] de haute fréquence caractéristiques de l'élément 72 ont été observées avec les oxydes provenant des queues de fractionnement des nitrates du groupe ytterbique, c'est-à-dire dans les mêmes oxydes où l'un de nous, il y a douze ans (G. Urbain, *Comptes rendus*, t. 152, p. 141, 1911) avait observé des raies d'arc qui, n'étant attribuables à aucun élément connu, ont été considérées comme appartenant à un élément nouveau, le Celtium.

De leur côté, MM. Coster et Hevesy ont observé dans des produits zirconifères d'origine norwégienne six raies de haute fréquence caractéristiques de l'élément 72.

Ce résultat a été immédiatement contrôlé par l'un de nous avec un échantillon de zircone. Les raies attribuables à l'élément 72 coïncident exactement [2] avec celles observées avec les terres ytterbiques, avec cette seule différence que la proportion de l'élément 72 y est notablement plus grande.

Nous concluons de ces faits que MM. Coster et Hevesy sont mal fondés à revendiquer la découverte de l'élément 72 alors que nos publications sont de 8 mois antérieures à la leur, et qu'il s'agit bien du même élément.

Les clichés que nous possédons n'ont pu être reproduits et publiés à cause de la faiblesse des raies, mais nous les tenons à la disposition de MM. Coster et Hevesy qui pourront les examiner de concert avec nous au laboratoire de M. de Broglie où ils ont été obtenus.

Eu égard aux considérations théoriques qui forment la base de l'argumentation de MM. Coster et Hevesy il nous suffira de dire :

1°. Dans sa première note de 1911, Urbain a pensé pouvoir s'appuyer sur des variations de propriétés magnétiques et chimiques pour attribuer au celtium des propriétés intermédiaires de celles du lutécium et du scandium. Les faits observés depuis imposent de faire des réserves sur cette question d'interprétation, d'ailleurs secondaire au point de vue qui nous occupe.

2°. L'examen du spectre de haute fréquence dans les produits celtifères a précisément eu pour but de rechercher si cet élément pouvait être identifié à l'élément 72. Il eût été dès lors singulier après avoir observé ce spectre de haute fréquence de ne pas l'attribuer au celtium. Mais quand bien même le spectre d'arc et le spectre de haute fréquence en question ne seraient pas attribuables au même élément, comme nous l'avons logiquement admis, il n'en resterait pas moins vrai que nous avons découvert les premiers l'élément 72. En conséquence MM. Coster et Hevesy n'avaient pas le droit de lui donner un nom nouveau.

3°. MM. Coster et Hevesy attribuent à l'élément 72 la valence 4, ce à quoi nous n'avons à faire aucune objection. La question est de savoir si un élément tétravalent peut accompagner les terres rares de manière à se retrouver dans les dernières eaux-mères des fractionnements. Or le cas se présente constamment pour le cérium, à la fois trivalent et tétravalent. Il y a même, entre ces deux états du cérium, un constant équilibre. Le cas se présente encore pour le thorium qui, dans les minerais, accompagne toujours les terres rares trivalentes et dont on retrouve toujours des traces, après traitements, à la queue des fractionnements qui classent les terres rares dans l'ordre de leur solubilité.

De même on retrouve constamment le germanium avec l'arsenic ou le molybdène, l'indium avec le zinc, etc.

On ne saurait donc affirmer, comme l'ont fait MM. Coster et Hevesy, que l'élément 72 ne peut se retrouver dans les dernières eaux-mères des fractionnements des termes ultimes de la série des terres rares si ce n'est pour en conclure que nous n'avons pu observer son spectre là où cet élément ne pouvait se trouver. Un tel raisonnement est évidemment sans valeur et ne présente d'autre intérêt que d'être tendancieux.

G. URBAIN.
A. DAUVILLIER.

Paris, le 27 janvier.

[1] Les autres raies de cet élément coïncident avec des raies du lutécium et du néoytterbium.

[2] Un cliché effectué avec un autre fractionnement de terres ytterbiques, en améliorant les conditions expérimentales (oxydes fortement comprimés et calcinés dans le vide, foyer anticathodique linéaire. etc.), nous avait déjà fourni des lignes plus nettes et plus intenses, mesurables avec plus de précision. Nous trouvions ainsi : $\beta_2 = 1372{\cdot}8$ et $\alpha_1 = 1564{\cdot}1$ U.X., chiffres coïncidant avec les valeurs interpolées. La recherche du zirconium, effectuée par le spectre d'arc et le spectre de haute fréquence, a donné un résultat négatif.

Meteorological Nomenclature and Physical Measurements.

WITH concern, not unmixed with amusement, I have read in the issue of NATURE for January 27 the desponding reports about the "Position of the Scientific Worker" on p. 132, and Dr. Mill's playful banter about "Progressive Meteorology" on pp. 107-109. The uninitiated can scarcely fail to regard the latter as deriding some recent meteorological work as regards the choice of appropriate names and units of measurement for the physical quantities involved ; while I have good reason for regarding it as a serious effort to make plain some rough places in the path of future students of meteorology.

By way of illustrating the importance of units let me say that this week-end, by the accident of having to revive past memories of the physics of the atmosphere at a lecture in the University of Birmingham, I have happened upon two generalisations, new to me and perhaps also to other readers of NATURE, which Dr. Mill may regard as important for the comprehension of the general problem. One is that at the level of eight kilometres (all over the world, so far as our limited knowledge extends) normal isobars are also normal isotherms and the temperature is everywhere numerically two-thirds of the pressure. The other is that the range of temperature during the year at a selected locality of the earth's surface, possibly at any locality, is the saturation-adiabatic projection upon the surface of the range of temperature at any level above ground. The language is horrifying in its technicality ; but if the two propositions are true, even for comparatively restricted areas, they present a view of the normal state of the atmosphere which is worth remembering. With the terminology and units which I have employed they are easy to remember. If Dr. Mill will translate them into the vernacular which he favours he will find the statements much more difficult to word.

As to terminology, can any one estimate the debt which meteorology owes and will continue to owe to Bjerknes for the happy inspiration of the name "polar front"? What its real meaning is we have not yet found out; but it is a banner under which knowledge is enlarged. Or can any one say how the fate of Scott's Antarctic expeditions would have been affected if the meaning of "katabatic" had been understood in 1900. The development of the science of meteorology is a strenuous task. I do not suppose that Dr. Mill intended his criticism to be as destructive as uninitiated readers will think it to be. Somehow the picture which his review calls to mind is that of the three jovial huntsmen: "We'en powlert up and down a bit and had a rattling day." There are occasions when there are obvious discontinuities in psychology. Once upon a time, years ago, as college tutor in Cambridge I went down to see the boat-races. Being late, I found the leading boats of the first race already past the winning post, among them one of my own college which I had gone down to cheer. It was a perfect summer's day, and I found the crew in lonely solitude, lolling about in the boat after their labours, in all the attitudes of summer idleness. I went up to them and by way of being cheerful remarked, "You seem to be having a picnic." To my astonishment no one spoke; and presently the man nearest to me grunted, "It's been grim earnest here, Sir." They had been chased all over the course and were too exhausted to stand and too despondent to speak.

I am not yet come to that pass; but I feel in like manner that Dr. Mill in his dignified position has not really appreciated what the stress of meteorological work means. It is only too true that our craft rows its course in continual danger of being bumped by a crew that bases action upon its ignorance of the subject and not upon its knowledge. That is precisely the situation which the National Union of Scientific Workers finds so depressing, and to me, with a full experience of every phase of success and failure in boat-racing, the cheers from the bank to the boat that is pressing us are a reminder that science in this country might be encouraged rather than depressed if the members of its own household would visualise the situation a little more deftly.

I have never supposed that new units and new terminology can be anything but distasteful to the veteran, even to myself. I am not so self-confident as to assume that the ultimate solution will be found in the way that seems to me the most direct. All I ask is that those who criticise should face the problem with a policy. I find it difficult to regard the ordinary British attitude as indicating a policy: it is our income-tax which goes to teach every child in the country the metric system, and every child who learns science is taught at our expense to use the metric system and to "chuck it" as soon as he leaves school. If that is really an educational policy I can find no polite adjective in the dictionary which will describe it.

NAPIER SHAW.

January 30.

The Identity of Geber.

I AM glad to see that Mr. Holmyard (NATURE, vol. 110, p. 573) has also been led to doubt the validity of much of the criticism of the authenticity of the Latin works attributed to Geber. In the recent work of Prof. A. O. von Lippmann "Die Entstehung und Ausbreitung der Alchemie," the destruction of the Latin authorities has passed all bounds of restraint. A treatise which refers to Geber, or gives doctrines resembling his, which could possibly have been written before 1300, the date of the earliest Geber MS., is *pseudographisch*, *untergeschoben*, or the work of *Fälscher*. Important treatises are dismissed in footnotes without discussion as spurious. Geber's fall is bringing down many other authors. In some fairly early authorities there are references to *a* Geber, but in quoting these in other parts of his book, von Lippmann has left out the text containing the name of Geber. In other places, in his quotations, the omission of "et" (=and) is marked by a row of dots, and in giving the *content* of the opinions of other writers, Lippmann's book becomes quite untrustworthy when it reaches the Latin authors.

The discovery of the original MSS. is the final test. Boerhaave ("Elementa chemiæ," 1732, i. p. 15) says that the Arabic works of Geber were translated by Golius, who was professor of oriental languages at Leyden; in Shaw's translation of Boerhaave's book (1741, i. p. 26, note 3) it is stated that Golius presented the MS. of Geber to the Leyden library, translated it into Latin, and published it in the same city, first in folio and afterwards in quarto, under the title "Lapis Philosophorum." In the catalogue of Golius's library I find that there is mention of an Arabic MS. bearing the name of Geber and treating of alchemy, but the few MSS. examined by Berthelot, including MSS. from Leyden, were quite different from the works in Latin. The Leyden MS. may have been lost (as some of the Greek ones at Paris have been).

In the Latin Geber there are long arguments refuting those who deny the possibility of the Great Work. Berthelot says that an Arabic writer of the previously assumed period of Geber (*c.* 750–800 A.D.) would have had no doubts as to this possibility. This is incorrect. Prof. Wiedemann, whose services in this branch of historical research have been extremely valuable, has published MSS. of this period, in which it is said that the failure of alchemists to carry out their work of transmutation had become "proverbial" (Abu Jusuf, d. 798; Aldschaziz, d. 869, who said there was no alchemy; Alkindi, d. 873, who said all alchemists were liars). This argument, therefore, falls to the ground.

The logical arguments are, said Berthelot, reminiscent of the Schoolmen of a later period (say 1200–1250, in which he puts the Latin author). He does not say what these arguments are, but those I have met with are taken largely from Aristotle, whose works were translated into oriental languages at an early period.

Geber, according to Berthelot, showed an advanced rationalism in contesting the influence of the planets, which was accepted by the Arabic Jâbir, whose works are extant in Arabic, but are different from Geber's. A belief in astrology cannot be used to date any historical period, and apart from this, the Latin Geber explicitly admits the influence of the stars, but says "The work will be duly performed by Nature *under a due site* convenient for it, without any previous considerations of it."

"The ideas and facts developed in the writings of the pseudo-Geber," said Berthelot, "are frequently expressed in the same terms in the authentic works of Roger Bacon." I do not wish to enter into a discussion of the authenticity of these particular works of Bacon; it is only necessary to remark that in the one to which Berthelot's remarks seem to apply the name of Geber is cited, through Avicenna's "De Anima" (the phrase is given by Hoefer, i. 329, as Bacon's), which work is, naturally, condemned by Lippmann, on quite inadequate grounds, as "pseudographisch." That it differs in style from the "Canon" is probably correct, but Newton's "Daniel and the Apocalypse" differs in style from the "Principia." Avicenna's "De Anima" was condemned as spurious by Dr. James in his "Medical Dictionary" (London, 1743, vol. i., unpaged). The quotation in Avicenna is not to be found in the Latin works of Geber.

According to Berthelot the "Liber Septuaginta" (the Latin MS. of which was noted by Hoefer, whose valuable pioneer work has been considerably underestimated) is entirely different in style and content from the Latin Geber, although he attributes it, on what seem insufficient grounds, to Jâbir. There are some strikingly similar passages in the above work and in the Latin Geber, though I do not assert that they had the same author.

For some years I have asserted in my lectures that the criticisms of Berthelot were unsatisfactory. There are many other reasons why the arguments of Berthelot should be rejected and a new start made. Mr. Holmyard inclines to the original view that the Arabic Jâbir and the Latin Geber are one; my own view, which like his is still hypothetical, is that a Greek, Syriac, or Hebrew MS. may be as likely to be the *original* source as an Arabic one. The details of the life of Geber are very contradictory, but he is said to have been "a Christian who afterwards became a Mohammedan," or "of Tarsus." This is suggestive.

The "Summa perfectionis" is probably the earliest Latin work of the group attributed to Geber. It differs only little from the Greek writings of Alexandrine authors in its ideas, and the doctrines it teaches do not seem to represent that remarkable advance which is held to throw doubt on its early date. The "Testamentum" referred to by Mr. Holmyard differs in content and outlook from the "Summa"; it does not appear in the earliest printed edition of Geber's works (British Museum, catalogued as possibly printed at Venice in 1475, but I am informed by the authorities in the Incunabula Department it was probably printed at Rome not before 1480–1490). The "Testamentum" first appeared in the Vatican edition (? 1525; the 1480 was also a Vatican edition; Kopp, Hoefer, and Berthelot have been confused by editions of Geber which they have not seen). The "Liber de investigatione" may be a compilation by some later writer. The "Alchimia Geberi," of which Kopp, Hoefer, and Berthelot speak, is not a separate work, but merely an edition of Geber's works. As Mr. Holmyard seems to have gone some distance in another direction, I thought it useful to state briefly what conclusions I have reached; the detailed justification of these would take up far too much space. The "pseudographic" school, however, do not seem to have made out their case.

J. R. PARTINGTON.

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The Stoat's Winter Pelage.

A FRIENDLY stoat, which has made our flower-garden and rockery his hunting-ground for mice and voles during the last three years, has donned his winter livery of ermine, and become very conspicuous—a snow-white little athlete—amid the greenery of the present exceedingly green winter.

This seasonal change of the stoat's brown summer pelage to creamy white is regulated, not by winter temperature, but by latitude. Invariable in the stoats of the Scottish Highlands, nearly so in those of the Scottish Lowlands, it becomes gradually less frequent towards the English Midlands; until in the southern counties a complete change of hue is exceedingly rare. This change is not due to the growth of a new coat; it is the old fur that becomes white. Nor is prevailing temperature the cause of change. Here, on the western Scottish seaboard, winter is usually very mild; snow seldom falls and still more seldom lies. *Clianthus puniceus*, from the north island of New Zealand, and *Abutilon megapotamicum*, from Brazil, have been flowering profusely on walls in the open all through this winter; yet our stoats regularly assume the protective winter garb of circum-polar animals; while in Warwickshire and Leicestershire, where the average winter temperature is far more severe, a complete change in the stoat's pelage very rarely occurs.

May we not recognise in this a heritage from the last ice age? So long as the land so far south as Herts lay under the ice, stoats in the Thames valley and south thereof must have worn the ermine pelage—at least in winter, and so did those which followed the ice in its northward retreat. But some thousands of temperate seasons have enabled the race of stoats that remained in the southern counties to dispense gradually with a costume which has become the very reverse of a protective disguise.

A few thousand years more and it may be as difficult to find a white ermine in Caithness as it is now in Cornwall!

HERBERT MAXWELL.

Monreith, Whauphill,
Wigtownshire.

Stirling's Theorem.

FOR very large values of n, Stirling's theorem,

$$i.e. \ \mathrm{Lim} \frac{\underline{|n}}{n^n \epsilon^{-n} \sqrt{n}} = \sqrt{2\pi},$$

reduces in its logarithmic form to

$$n \log n - n = \log \underline{|n}.$$

It is in this form that the formula is required in Planck's radiation theory. Wanting to use this formula, and unwilling to make my students go through the proof of Stirling's theorem as given, for example, in Chrystal's "Algebra," I thought of the following deduction, and should like to know if it is sound or if it has been given before.

When $dn = 1$

$$\log n = \frac{d}{dn} \log \underline{|n},$$

and since n is to be very large the value of dn is an infinitesimal. Therefore we may say

$$\log n \, dn = d \log \underline{|n}$$

$$\therefore \int \log n \, dn = \int d (\log \underline{|n})$$

$$\therefore n \log n - n = \log \underline{|n},$$

which is the form required.

JOHN SATTERLY.

University of Toronto,
Toronto, Canada,
January 1.

Stonehenge: Concerning the Four Stations.

JUST within the surrounding earthwork of Stonehenge there are two stones symmetrically placed with reference to each other on opposite sides of the centre. There are also two low earth heaps or mounds in corresponding complementary or reversed positions. A general description of these "Four Stations" was given by me in NATURE for April 1, 1922 (vol. 109, p. 410), with a plan (reproduced herewith, Fig. 1) drawn to scale and photographs of the stones.

The two so-called mounds are of very slight elevation, and are scarcely noticeable on the ground: each has a sort of hollow or crater in its centre. By Petrie's system the two stones are numbered 91 and 93, and the corresponding pair of mounds Nos. 92 and 94.

In the hollow of mound No. 94 Colt Hoare reports that he found "a simple interment of burned bones" ("Ancient Wilts," i. p. 145). On the strength of this discovery it has been assumed that the two mounds are Round Barrows, and (based on this assumption) it is inferred that Stonehenge was constructed probably near the end of the Bronze Age or perhaps even later.

"Round barrows were erected towards the end of the Neolithic Age in Scotland, Yorkshire, and Derbyshire; but Mr. Stone is, I believe, the first to suggest that a round barrow of that period exists at Stonehenge."

But I made no such suggestion—in fact, the special purpose of my communication was to show that the so-called mounds were *not* barrows. Perhaps Dr. Rice Holmes will re-read my letter in NATURE of April 1 last.

The fact that "a simple interment of burned bones" was found by Colt Hoare in the hollow of site No. 94 is, of course, no evidence that the place was a barrow. Similar casual interments of burned bones were also found deposited in the adjacent "Aubrey Holes," which obviously were not the sites of barrows.

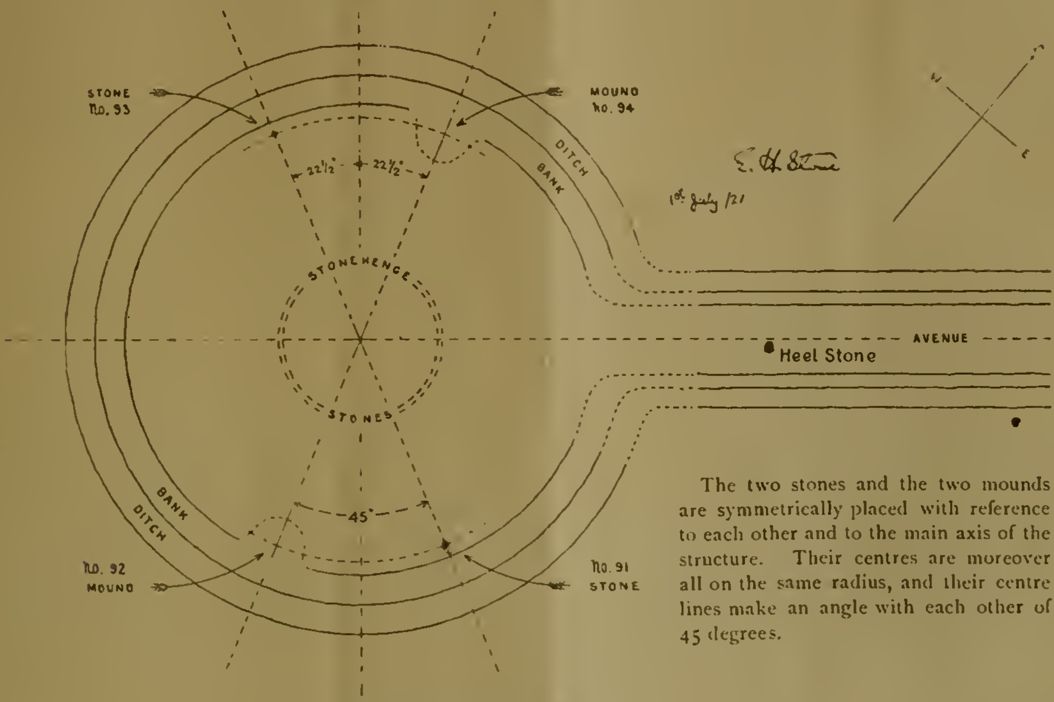

FIG. 1.—Plan of Stonehenge. Scale—120 feet to 1 inch.

The advocates of a Bronze Age date for Stonehenge specially rely upon this as conclusive evidence in support of their theory. Dr. Rice Holmes, for example, makes the somewhat positive assertion as follows:

> "The stones [of Stonehenge] were certainly not standing when Round Barrows were first erected on Salisbury Plain; for one is contained within the *vallum*, which, moreover, encroaches on another" ("Ancient Britain," p. 476).

In my letter in NATURE (April 1, 1922), I gave evidence for the opinion that these two earth heaps are not the remains of barrows, but are the sites of a pair of stones that had been removed. These stones, when in position, corresponded exactly with the pair of stones which still remain in place.

In the *Antiquaries Journal* for October 1922 (p. 344, footnote), Dr. Rice Holmes, in reference to this matter,[1] remarks:

[1] Dr. Rice Holmes makes a mistake in his reference, which he gives as NATURE, April 29, 1922, p. 563.

That these mounds are really positions which were once occupied by stones has, however, now been placed beyond doubt by the excavations lately carried out by Col. Hawley, in the course of which the crater or hollow in the middle of one of these sites (No. 92) was completely cleared down to the original chalk rock. I inspected the bottom of the hole when it had just been cleared out, and it was evident that it had been dug as the foundation pit for a large stone. There was no indication of any barrow having ever existed on the site.

In his report published in the *Antiquaries Journal* for January 1923 (pp. 15-16), Col. Hawley, in reference to this, remarks:

> "Nearly in the middle of the place [No. 92] was a large hole. Sir Richard Colt Hoare mentions having opened it without result, consequently it was in a very disturbed state and afforded nothing of interest until it had been emptied. It was then seen that it must formerly have contained a large stone, perhaps about the size of the one [No. 91] lying near the rampart a little way to the east,

and the bottom showed irregularities indicating the pressure upon it of an irregular base of a stone.

"On the north side, forming part of the hole, was an incline in the solid chalk for introducing the stone somewhat similar to those met with in the Stonehenge circle.

"The hole was about 4 feet deep."

It appears probable that most of the material of these so-called mounds is merely the spoil thrown out by Colt Hoare in making his excavations. Before Colt Hoare's time we find these two sites are always referred to as cavities or depressions (not as mounds), and we may infer that these cavities were the hollows left after the removal of the stones. The following extracts are quoted from well-known authorities:

William Stukeley, 1740.—"The two cavities in the circuit of our area, very probably were the places where two great stone vases were set" ("Stonehenge," p. 14).

John Wood, 1747. — "Two stone Pillars appear at the foot of the inner Bank next the Area in which the Building stands; and these are answered by two Spherical Pits at the foot of the same Bank" ("Choir Gaure," pp. 43-44).

Dr. John Smith, 1771. — "Directly north and south of the temple, just within the vallum of the ditch, is the appearance of two circular holes, encompassed with the earth that was thrown out of them. But they are now almost effaced by time" ("Choir Gaur," p. 52).

Waltire, 1792. — "There are two clayed pits, and two stones near the ditch" (Quoted in Britton's "Wilts," ii. p. 122.)

Rev. Richard Warner, 1801.—"Two other smaller stones are found on the inner bank of the surrounding ditch, exactly opposite to each other, in a direction east and west; as well as two circular depressions, about sixteen feet diameter, in the same bank, one lying S.S.E. and the other W.N.W." ("Excursions from Bath," p. 177).

We may conclude therefore:

(*a*) That the sites Nos. 92 and 94 were once occupied by stones corresponding with the now existing stones Nos. 91 and 93.

(*b*) That in the Bronze Age period the stone had already been removed from site No. 94, as a cremated interment was found by Colt Hoare in the foundation pit.

This latter conclusion (*b*) may prove of further interest in connexion with the history of Stonehenge. If supported by other evidence, it may be taken to indicate that in the Bronze Age the dilapidation of Stonehenge had already begun.

E. HERBERT STONE.

The Retreat, Devizes,
January 15.

A Double-Vertical-Reflection Mirage at Cape Wrath.

ON the morning of December 5, 1922, about 10.30 A.M. G.M.T., Mr. John Anderson, lightkeeper at the Cape Wrath Lighthouse, Durness, observed a mirage of an unusual character. Mr. Anderson focussed his telescope on a sheep which was grazing on top of a conical hill (height about 200 feet) about a quarter of a mile away, and immediately noticed an unusual appearance in the atmosphere around. On swinging the telescope slightly upward, he observed that a belt of the atmosphere appeared to be land and sea, giving a perfect representation of the whole of the coast line from Cape Wrath to Dunnet Head.

The appearance in the mirage was an exact replica of what would have been seen from a distance of about 10 miles out at sea. In a direction south

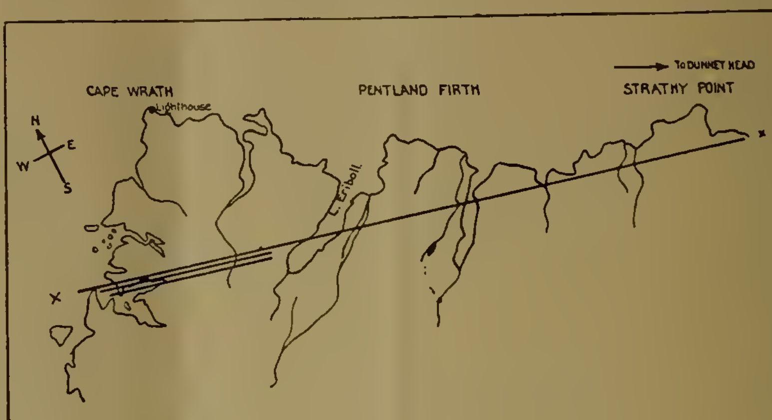

FIG. 1.

FIG. 2.

of the lighthouse there were three repetitions of the mirage one above the other, with sea separating each pair. The entrance to Loch Eriboll and the other bays could be seen and easily recognised in the main mirage, though Cape Wrath itself was rather indistinct.

The accompanying map (Fig. 1) shows the apparent position of the mirage and the outline of the coast, while the sketch (Fig. 2) gives a rough idea of how the country appeared to the observer. The mirage was hidden at one point by a hill.

The mirage was practically invisible to the naked eye, and was only visible from a very restricted area. Mr. Anderson states that it was not visible at a distance of 20 yards either way from his original position, but was still visible 4 or 5 yards from that point. Mr. Anderson estimates the apparent height of the image above the ground as about 1000 feet, in a southerly direction, while the distance from Cape Wrath of the triple image shown on the map is about 12 miles.

The phenomenon was observed for about thirty minutes, when it was blotted out by heavy, dark clouds from the south-west. Within a short time the sky was darkly overcast and rain began to fall, lightly at first, accompanied by slight fog; later rain fell very heavily, the raingauge giving a total of 1·97 inches for the afternoon.

The mirage was seen by practically all the residents at the station.

The meteorological conditions do not point to anything extraordinary. The synoptic chart for 7 A.M. shows an anticyclone centred westward of the mouth of the English Channel, with a very slight ridge of high pressure extending over Ireland and up the West Coast of Scotland. The temperatures at 7 A.M. were 48° at Wick and Stornoway, 51° at Castlebay, and 55° at Aberdeen. There was therefore a fairly sharp discontinuity of temperature along a line just south of Cape Wrath. The wind at 7 A.M. at Cape Wrath was from west by north. By 1 P.M. a secondary depression had advanced from the Atlantic, and was centred about 50 miles north of Stornoway, giving a south-westerly trend of isobars over the coast line from Cape Wrath to Dunnet Head. The temperature at Stornoway was now 52°, but only 47° at Wick, where the wind was still light.

The mirage was seen at 10.30 A.M., at the time when the wind was backing in front of the depression. The Deerness anemograph shows a slight backing of the wind from west by north at 10.30, and a further slight backing to west by south about 11 A.M. The wind blew steadily from west by south until 3.30 P.M., when it shifted to north in the rear of the secondary.

It will be noted that the phenomenon occurred at a time when the warmer current in front of the secondary depression had not completely displaced the colder air from the immediate vicinity of the coast line. There would remain a cold pocket of air under the cliffs, and other masses of cold air would probably be trapped by the hills near the coast.

The only suggestion which I can offer as a basis of explanation for the phenomenon is that there was a sharp surface of discontinuity—approximately vertical—between the warm air over the sea and the cold air under the cliffs, and that some distance inland there was another nearly vertical surface of discontinuity between the cold air near the coast and warm air which had penetrated inland through a gap in the hills south of Cape Wrath.

Reflection of light at two such surfaces of discontinuity would account for the phenomenon, the effect being that produced by two mirrors, one in front, and one behind, the observer. There should be a small amount of reflection at any sharp surface of discontinuity, perhaps sufficient to account for the phenomenon being visible through a telescope. The extremely small limit of the region from which the phenomenon was visible would place the inland discontinuity near to the observer. The effective surface of the mirror may have been quite small.

Mr. Anderson records that there was a slight fog when the rain came. The fog would be produced by the mixing of the warm humid current with the colder air which had previously remained over the coast.

The phenomenon has been called a mirage, but the mirage as ordinarily understood is either an effect of refraction in air stratified horizontally, or, in the case of inverted mirage, is an effect of reflection at a horizontal surface at which there is a rapid change of density. But the admitted theory of formation of inverted images confirms the claim that there should be reflection at a surface of discontinuity of density. The phenomenon described above might perhaps be named a "vertical-reflection mirage," to distinguish it from the ordinary mirage due to refraction or reflection in air stratified horizontally.

No other records of similar phenomena can be traced, probably on account of the fact that such mirages are never likely to be visible to the naked eye. The telescope is useful in such cases only in so far as it limits the amount of light reaching the observer's eye. A plain tube without leuses would probably have shown the mirage more clearly than a telescope.

Mr. Anderson has been keeping a watch for others, but so far without success. This particular observation has been perhaps due in part to a series of happy accidents, in that the observer happened to be in the best position to note the effect, at the time when a wandering sheep roused his curiosity. Much credit is due to him for the trouble he has taken to draw the map and sketch, and to write a very detailed account of what he saw.

D. Brunt.

Meteorological Office, Air Ministry,
January 26.

The Sugar-Cane Mealy-Bug.

I have just received a very interesting paper on the sugar-cane mealy-bug (*Pseudococcus sacchari* Ckll.) from Mr. W. J. Hall, of the Ministry of Agriculture, Egypt. He describes the insect as being so injurious that "the whole future of the industry hangs in the balance." When I was recently in Madeira I examined the sugar-canes wherever I went, and found only a sparing and local infestation by *P. sacchari*. I had no microscope with me, but the determination was confirmed by Mr. E. E. Green. The insects may be found on the canes near the cliffs below the new road, a short distance west of Funchal. It is certainly worth while to determine why the pest is so serious in Egypt, and scarcely noticeable in Madeira. It may be that there is more damage in Madeira than I thought, but probably some efficient parasite will be found there. By collecting a quantity of the white material and placing it in a box, the parasites might be bred. That there is a parasite we know for certain, as my first sending from Funchal to Mr. Green could not be positively determined, consisting only of a mass of waxy secretion with fragments of the coccid, along with larvæ and pupæ of a parasitic Dipteron.

It is worth while to record at this time the occurrence of a really dangerous pest in Madeira, the *Aleurothrixus howardi* (Quaintance), on citrus in Dr. Grabham's garden in Funchal. It was determined for me by Dr. A. C. Baker of the U.S. Department of Agriculture. The infestation, while local, was very heavy, and if the insect spreads it may become a serious menace to the cultivation of oranges and related fruits.

Another potential pest found in Madeira is the rose-weevil *Pantomorus fulleri* (Horn). A single specimen was given to me by Mr. A. C. de Noronha, who found it in the vicinity of Funchal. It was identified by Dr. G. A. K. Marshall. As no other specimens have been found, it has perhaps not succeeded in getting established.

T. D. A. Cockerell.

University of Colorado,
January 2.

Definitions and Laws of Motion in the "Principia."

By Sir GEORGE GREENHILL.

MACH'S "Historical Lectures on Mechanics in its Development" ought to have a great influence on the treatment of the subject, with an English version from the Open Court Company. Mach has many a shrewd deep criticism to make on Newton's "Principia," and the present remarks are intended as an amplification of some of his scientific animadversion. It would have been worth his while to examine the previous state of the theory of dynamics to see what laws were current before the statement as given by Newton. These laws must have been enunciated, not only to give precision to the subject, but at the same time to correct and contradict previous fallacy and error, and it would be valuable to have a record in historical development.

The First Law must have excited incredulity, as contradictory to common observation of a body in motion, soon coming to rest of itself; and when the heavenly bodies were pointed at, a divine Primum Mobile was postulated to keep them going eternally, in the pious reflections of Aristotle, quoted in the former conventional manner at the end of the "Principia," and suggesting Napoleon's criticism of Laplace.

Axiomata sive Leges Motus. Lex I. Corpus omne perseverare in statu suo quiescendi vel movendi uniformiter in directum, nisi quatenus a viribus impressis cogitur statum illum mutare.

Similar statements can be traced in the writings of Aristotle and Plutarch. But it would be more instructive if we were told something of previous ideas contradicted in this Law, such as "A body in motion will come to rest of itself," as in observation of daily life, ignoring the reason and cause.

Lex II. Mutationem motus proportionalem esse vi motrici impressae, et fieri secundum lineam rectam qua vis illa imprimitur.

A vector change of momentum, *motus*, is indicated here; but the Law requires amplification in a commentary-corollary. *Motus* is quantity of motion, called momentum to-day, and *mutationem motus* requires to be qualified as time change, rate of change per time change, per unit of time; not per length or distance, which would imply energy or *vis viva*, an idea not extant in Newton's day.

Translated into our algebraical symbols, quantity of matter, *quantitas materiae*, of Definition I is denoted by W, lb. (in French it would be denoted by P, kg., for *poids, pondus*). Here W, the *Pondus* of our *Corpus*, is measured by weighing it in the scales, corrected for buoyancy of the air, and this is an operation susceptible to the greatest accuracy in physical measurement.

The velocity is v, in f/s (feet per second), so that the quantity of motion is Wv, lb.-ft. per sec., according to Definition II. Velocity v is not so easy to measure to equal accuracy as W.

Then, according to Law II, quantity of motion Wv acquired (from rest) under a force F acting for t seconds, is proportional to Ft (called the impulse), and expressed in a proportion, $Wv \propto Ft$, leaving the unit of force to choice.

The absence of the algebraical sign of equality, $=$, will be noticed as not employed in the "Principia." But in any numerical calculation, equality must be introduced by the appropriate constant factor.

Working with the practical gravitation Unit of Force, the only one in use up to fifty years ago, and still the only one capable of exact measurement, and taking our unit as the gravitation heft of a pound weight, the sign of variation, $\propto$, is replaced by the sign of equality, $=$, in the variation above by introducing g in the right place, and writing it in a homogeneous form

$$(1)\ \underset{\text{(lb.)}}{W}\ \underset{\text{(sec.)}}{\frac{v}{g}} = \underset{\text{(lb.)}}{F}\ \underset{\text{(sec.)}}{t}$$

so as to verify when $F=W$, with $v/g=t$, $v=gt$, as in a free vertical fall of the body; $t=v/g$ being the number of seconds of descent to acquire velocity v, ft./sec.; in most practical problems it is near enough to take $g=32$, ft./sec.^{2}, in round numbers.

Then if s feet is the distance required to get up speed v from rest in t seconds, the average velocity

$$(2)\ \frac{s}{t}=\frac{1}{2}v\ ;$$

and multiplying into equation (1)

$$(3)\ \underset{\text{(lb.)}}{W}\ \underset{\text{(ft.)}}{\frac{v^2}{2g}} = \underset{\text{(lb.)}}{F}\ \underset{\text{(ft.)}}{s}$$

and $\frac{v^2}{2g}=s$ in a free fall, where $F=W$.

And in a flying start, from velocity u,

$$(1)^*\ W\frac{v-u}{g}=Ft,\ (2)^*\ \frac{s}{t}=\frac{1}{2}(v+u),\ \ (3)^*\ W\frac{v^2-u^2}{2g}=Fs.$$

With these three equations, (1), (2), (3), any two of which imply the third, the young engineer may carry on for a long time in the linear dynamics, seen on the road and railway or in the air, up and down hill, getting up speed and checking it again with the breaks.

After that a variable force F may be introduced, as in Hooke's Law of the spring; a vibratory motion investigated, shown off in the pendulum, and seen in reciprocating masses of machinery, or a carriage body on springs. Here is theory enough to keep him going for a year.

Then after linear dynamics comes uniplanar dynamics, and the notion of rotation is introduced. A familiar illustration is always at hand in the door; every room has a door. The muscular sense of starting and stopping the rotation can be exercised; also in brandishing a stick, poker, bat, or club.

Angular inertia then requires measurement, although not mentioned in the "Principia," not even in "De motu corporum pendulorum" in Book II, or "In Horologiis et similibus instrumentis, quae ex rotulis commissis constructa sunt," where the *Corpus* may be the compound pendulum of a clock oscillating about its axle. Then Moment of Inertia requires definition,—the scalar sum of the product of every particle of the body by the square of its distance from an axis.

Thus, in "Matter and Motion," Maxwell reduces the uniplanar motion of any rigid body to an equivalent particle pair, rigidly connected, having the same total weight, the same centre of gravity, and the same moment of inertia about the centre of gravity.

The compound clock pendulum of Huygens is replaced in this way by its equivalent pair of particles, one being placed at O in the axle of suspension, and the other will be at P the centre of oscillation; and then OP is the length of the simple equivalent pendulum, a plumb bob P at the end of a thread OP.

Provided with these additional ideas in dynamics, the young engineer will be able to investigate the motion of the revolving parts of his machinery, such as a flywheel, a revolving shaft, a screw propeller, and the influence of the rotation of the wheels of a carriage.

Whatever the system of units employed, it is essential in the dynamical interpretation for g to be assigned its proper place, here under v. It must not be allowed to straggle and take cover under W, as in the old-fashioned treatise, where the author, to save trouble in writing and printing, adopted the mischievous delusive plan of replacing his W/g by the single letter label M, and then calling it the mass, a quantity *sui generis*, not its *Corpus*. He then wrote, with $v/t=f$, the acceleration, time rate of growth of velocity,

$$(4)\ F=Mf,\ \text{with}\ W=Mg.$$

These relations are not seen in the "Principia-Elements," where g does not occur explicitly but is concealed in the length L of the seconds-pendulum, $g=\pi^2L$. The "Principia" is chiefly kinematics; very little of kinetics until the second book, and then of experiments on fluid resistance, aways expressed in gravitation units.

Lex III. Actioni contrariam semper et aequalem esse reactionem: sive corporum duorum actiones in se mutuo semper esse aequales et in partes contrarias dirigi.

According to Maxwell, this Law—Action and Reaction are equal and opposite—amounts to no more than the definition of a stress, a pull or thrust, tension or pressure.

The sequel of Corollaries of Law III is important in introducing the ideas of vector composition, the conservation of momentum, and immunity of the centre of gravity to the internal actions and stress.

The Law was put forth probably as a contradiction to some accepted law in vogue before Newton, now forgotten. In some recent figurative language of the Press, we read "The pendulum is always swinging. Action, especially if violent, is apt to entail reaction." The former Law can still be traced in the popular idea current that the horse advances by pulling the cart harder than the cart pulls back. I remember a similar question about a double-headed express train; I was asked to explain what would happen if the second engine was going faster than the first: pulling harder I presume was meant.

The definitions come first in the "Principia," but we prefer to discuss them after the Laws, when the ideas they imply have been employed already in some tangible application, and so are capable of a better appreciation, and we can refer to them. Abstract definition requires to settle on some hard base of fact and comes after action in order of thought.

Definitio I. Quantitas Materiae est mensura ejusdem orta ex illius Densitate et Magnitudine conjunctim.

According to Mach, this is really no more than a definition of density, and *quantitas* is used as a synonym for *Corpus, Moles, Massa, Pondus*, five names to one entity. Nomina-Entia non sunt multiplicanda praeter quam necesse est.

Here *Corpus* would connote a body, *Moles* or *Mola* the bulk, *Massa* the aggregation of its stuff, and *Pondus* the quantity of its stuff measured out in a balance against standard lumps of metal called weights; revealed also roughly in the heft required to lift the body off the earth's surface.

The Greek equivalent for *Massa* would be μάγμα, μᾶζα, something kneaded and fashioned into shape; and the distinction in Latin between the words is brought out clearly in Ovid's lines (*A. A.* iii. 219):

"Quae nunc nomen habent operosi signa Myronis,
Pondus iners quondam duraque massa fuit";

assigning the quality of Inertia to *Pondus*.

But because Newton in this definition goes on to say—Innotescit ea (Quantitas) per corporis cujusque Pondus. Nam Ponderi proportionalem esse reperi per experimenta Pendulorum accuratissime instituta, uti posthac docebitur (meaning experiments to prove that the quality of the Matter does not matter)—it is rigidly insisted to-day in elementary instruction that *Pondus* should never be used except in this subsidiary sense of the accident of the gravitation of it, due to its situation on the surface of the earth. Moreover, we find Newton using *Pondus* elsewhere in both of the meanings of ordinary language; as, for example, in his preface—Unde solvitur in omni aptorum instrumentorum genere Problemata. Datum pondus data vi movendi. Sic pondera aequipollent ad movenda brachia Librae, quae oscillante Libra sunt reciproce ut eorum velocitates sursum et deorsum: hoc est, pondera, si recta ascendunt et descendunt, aequipollent, etc.

Definitio II. Quantitas Motus est mensura ejusdem orta ex Velocitate et Quantitate Materiae conjunctim.

This is the quantity called momentum to-day, our Wv, lb.-ft. per sec. And—Motus totius est summa motuum in partibus singulis—requires amplification to-day of "sum" to "vector sum."

Definitio III. Materiae Vis Insita . . . etc., is qualified as undistinguishable from *Inertia massae*, the *pondus iners* of Ovid, so here the two names are convertible, and one of them would serve.

The *Vis Impressa, Vis Centripeta, Vis centripetae Quantitas Absoluta, Acceleratrix, Motrix* (felt forcibly on the top of a motibus), and so on of the subsequent Definitions display a curious profusion of the word *Vis*, as much as in Hooke's vaunted Law: Ut Tensio sic Vis.

Vis, like moment, momentum, moment of momentum, moment of inertia, is a word too hackneyed in dynamics. A. N. Whitehead, in the "Concepts of Nature," uses the word moment to mean "all Nature at any instant." "Two moments of the same family are parallel." "A point flash of Nature is an event particle."

In Definition I, density is taken as the primary property of matter, although left undefined by Newton; while *Quantitas Materiae*, our W or P, is the product of density and volume.

The *Materiae Vis Insita* of Definition III is described as the same as *Inertia Massae*. This, however, is not the definition of *Massa*, but *Inertia*, although the two are treated as the same thing in modern interpretation.

Newton is not consistent with himself, as asserted, in always using *Pondus* as meaning the attraction of the earth on a body on the surface. As often as not he uses *Pondus* in the popular acceptation, as in the Act of Parliament,and a search in the "Principia" will reveal numerous instances.

This distinction, insisted on so carefully in modern instruction, was ignored in language and thought till about fifty or sixty years ago, when Absolute Measure was first introduced into dynamical teaching.

The artless definition of Mass, as the quantity of matter in the body, is near enough to serve in a dictionary, as a synonym in one line. It is merely the selection of a new name as a label in the long list already in Def. I. But a real definition will give at the same time the best way to measure the quantity. In a recent Royal Society memoir, on "mass determination" as the author is careful to call it, the question of its measurement turned on a "Study of the Balance, in its greatest precision, in a projective series of weighings of small masses," the most accurate of all physical operations we know.

Libra, sign in the Zodiac of the Balance, is an appropriate emblem of justice holding the scales.

It is contrary to the strict legal language of the Act of Parliament on weights and measures to start off with another artless definition—the weight of a body is the force with which it is attracted by the earth. At that rate, what is the weight of the moon, the sun? The definition is not supposed to apply to a body, so long as it is not terrestrial.

The attraction of the earth on the pound weight as the unit of force (gravitation) will never be abandoned by the engineer, as it is susceptible to the same degree of accuracy of measurement as the operation of weighing.

But when Tait took in hand the reform of dynamical teaching, he altered the equations in our form of (1), (2), (3), (4) in a new way, with the view of exterminating g. He discarded the old *sui generis* mass, with unit of g lb., and taking mass in its new meaning of the invariable quantity of matter in the body, he measured it in terms of the Act of Parliament unit of weight, the pound weight. This involved him in a change in the unit of force, to what was called a poundal, such that the engineer's gravitation unit of force, the pound (force), was equivalent to g poundals.

Tait's change merely amounted to labelling M the quantity formerly labelled W. But he insisted on retaining $W = Mg$, and so measuring what he called weight in poundals, contrary to the strict law of the Act, and rendering himself liable to a fine for every offence. Better if Tait had retained the letter W for lb., writing the equation $P = Wf$, and rejecting the useless $W = Mg$, as perpetuating the old *sui generis*, and breaking the law in the Act of Parliament.

This trouble of mere terminology would be exorcised if the habit was inculcated of always stating the unit of a dynamical quantity, as, for example, of a mass M, g, a weight W, lb. The engineer refuses to accept the poundal or to give a weight W in poundals. Scrap the name as useless, except for passing certain examinations.

To the masses in general the word mass implies a combination of bulk and density as in Definition I, as when we speak of mass of stuff, the mass of the earth—"Die Erde und ihre eigene ungeheure Last" (Mach). In ordinary language the mass will mean the multitude, or majority, as in the statement attributed to Herbert Spencer, "The mass of woman is insensible to gravity," which might mean a reminiscence of the ballroom floor; but this was before the women began to take themselves so seriously; and when we read the critic's snarl of the "Vast Mass of his writings consigned to Oblivion," Vast Mass here is forcible-feeble for *Major Pars*.

The word is spelt *Maas* in German; "Mass für Mass" is the title of the German version of Shakespeare's play "Measure for Measure."

Wegener's Hypothesis of Continental Drift.[1]

By PHILIP LAKE.

WEGENER'S hypothesis is based on the idea that the continental masses are patches of lighter rock floating and moving in a layer of denser rock, and this denser rock forms the floor of the oceans. Following, with a slight alteration, the terminology of Suess he calls the lighter material the Sial and the denser layer the Sima. Suess uses the words Sal and Sima, and thinks that the Sal covers the globe completely.

I shall not here discuss the possibility of Wegener's conception. He does not profess to explain completely why the continents should move, but he claims to have proved conclusively that such movement has taken place. It is the evidence on which he relies, and more particularly the geological evidence, that I propose to examine.

One of the arguments on which he lays great stress is derived from the relative frequency of different heights and depths upon the earth. His diagram of frequencies shows two well-marked maxima, one at about 100 metres above sea-level and the other about 4700 metres below it. Wegener concludes that two distinct surfaces standing at these two altitudes must have been involved in the subsequent movements. He assumes that these surfaces were originally level—or, more strictly, equipotential—and that they were the surfaces of the Sal and the Sima respectively. He holds that if originally there were only one such level, the deformation of that level could not produce two maxima and "the frequency must be regulated according to Gauss's law of errors."

In reality, if it is only a single level that has been deformed, it is improbable that the resulting altitudes

[1] Abridged from an address to the Royal Geographical Society on January 22.

will conform with the normal law of errors. The crust of the earth is not so constituted that each point can move independently of the rest, and the movements therefore are not analogous to the errors in a series of independent observations. According to the geological evidence the greater movements, which have most influence on the frequencies, are of a widespread character, and their general effect is to throw the surface into broad undulations. Upon these broader movements are superimposed the more intense but more local mountain-building movements.

Mr. G. V. Douglas points out in a paper to appear shortly in the *Geological Magazine* that if we start with a level, or equipotential, surface, and suppose it affected by movements of the types referred to, the resulting altitudes will necessarily give a frequency curve showing two maxima. The actual frequency curve is, in fact, perfectly consistent with ordinary geological conceptions and does not require the original existence of the two distinct surfaces postulated by Wegener.

Wegener imagines that at the close of the Carboniferous period the Sal formed one continuous patch covering about half the globe, and the Sima covered the rest. He professes that he has taken the forms of the existing land-masses, including their continental shelves: he has modified the present forms by unfolding the mountain ranges which have been raised since the Carboniferous period; and he finds that the different patches can then be fitted together into one continuous whole, like the pieces of a puzzle. It is evident, however, that Wegener has given free play to his imagination. In following the edge of the continental shelf he has allowed himself a very considerable amount of latitude, and he has not hesitated to distort the shapes of the masses. Few geologists who are familiar with mountain structures will attach much value to Wegener's estimates of the effect of Post-Carboniferous folding.

It is easy to fit the pieces of a puzzle together if you alter their shapes, but your success is no proof that you have placed them in their original positions. It is not even a proof that the pieces belong to the same puzzle. If Wegener's hypothesis rested solely on the evidence of fitting that he brings forward it might well be ignored. But there is more to be said for it than this.

In the Indian Peninsula the oldest fossiliferous deposits are of terrestrial origin and contain remains of plants and of reptiles. The flora is commonly called the Glossopteris flora and is very distinct from the contemporaneous flora of north-western Europe. There is a similar series of terrestrial deposits in South Africa and another in Brazil, both of which contain the Glossopteris flora and remains of reptiles. The Glossopteris flora occurs, moreover, in Australia, the Falkland Islands, the Antarctic continent, and in other parts of South America besides Brazil. In Wegener's reconstruction all these areas are brought together, and it is easy to understand why they should have a common flora and why that flora should be different from the flora of the distant Europe.

But the Glossopteris flora is found also in Kashmir, north-western Afghanistan and north-eastern Persia, Tonquin, northern Russia and Siberia. In Wegener's reconstruction all these areas lie far from the masses that he has grouped together in the south.

The Russian deposits are especially interesting. Not only do they contain representatives of the Glossopteris flora, but they also include reptiles of the same type as those which are found in South Africa, and several species of freshwater shells which are identical with those in the South African beds. Wegener's explanation has not by any means simplified the problem of the distribution of the Glossopteris flora and of the fauna associated with it.

In India, South Africa, South America, and Australia the system containing the Glossopteris flora begins with a boulder bed, which is universally admitted to be of glacial origin. These glacial deposits are now scattered over a wide extent of the earth's surface. Even if we admit movement of the pole, on the most favourable supposition the ice must have spread much farther towards the equator than the ice-sheets of the Pleistocene Glacial period ever did. Nor is it possible to invoke the aid of icebergs, for the associated deposits, except in the case of Australia, are all of terrestrial origin. With Wegener's reconstruction these difficulties disappear. The areas are grouped together and the pole may be placed conveniently in the middle of the mass.

But the boulder beds of this period are not limited to these areas. There is a boulder bed in the Salt Range which appears to be of the same age as the Talchir boulder bed of the Indian Peninsula. In north-western Afghanistan Griesbach found a boulder bed similar to the Talchir boulder bed, and in the beds overlying it he found several of the characteristic plants of the Glossopteris flora. According to Wegener's maps this boulder bed must have been deposited within 30 degrees of the equator of the period; and it cannot have been laid down at a great elevation, for the beds that conformably follow it include both marine and terrestrial deposits. Wegener's ideas have not very greatly reduced the area that must have been affected by the ice of the Permo-Carboniferous Glacial period.

There is another line of evidence that Wegener puts forward. There are five geological features, according to him, which occur on the two sides of the Atlantic and are re-united when the patches of Sal are fitted together.

The strike of the ancient gneiss of the Hebrides and northern Scotland becomes, he says, continuous with that of the gneiss of Labrador. The former, according to him, now runs from north-east to south-west, the latter from east to west. But according to the Geological Survey of Scotland the prevalent direction in Scotland is W.N.W.–E.S.E. or east to west. If Wegener's direction fits the other side the real direction does not.

The Caledonian folds of Scotland and Ireland, he says, become continuous with those of Newfoundland. But the Newfoundland folds are of considerably later date. If there was actual contact the earlier Scottish folding, in spite of its great intensity, must have ended abruptly at the line where separation was to take place ages afterwards, and on the other side of the line the commencement of the later Newfoundland folds must have been equally abrupt.

Farther south the Armorican folds of Europe, in Wegener's reconstruction, are continued by the Appalachian folds of North America, and no objection can be raised on the score of age. But a single coincidence of this sort has no value, for Wegener has adopted the simple plan of bending North America so that the ends of the two systems meet and the folds fall into line.

In Africa, according to Wegener, the ancient gneiss foundation shows a sudden change of strike at the head of the Gulf of Guinea, and in South America there is a similar sudden change at Cape St. Roque. When the two continents are brought together the two different strikes and the line of separation between them become continuous. But in bringing about this coincidence he gives to the gneiss north of the Gulf of Guinea a north-east to south-west strike, and this is very far from the truth. Over a large part of the area the actual observations indicate that the prevalent direction is from north to south.

In South Africa a folded mountain range runs from east to west. In Buenos Ayres a folded range belonging to the same period has been described. According to Wegener one was the direct continuation of the other. But before they reach the western coast the South African folds, and the range that they have formed, turn to the north and run roughly parallel to the western coast. Wegener's explanation of this deviation is far from convincing.

It will thus be clear that the geological features of the two sides of the Atlantic do not unite in the way that Wegener imagines, and if the continental masses ever were continuous they were not fitted as Wegener has fitted them.

Obituary.

Prof. George Lunge.

On January 3 Prof. Lunge died in his eighty-fourth year. For more than thirty years, from 1876 to 1907, he held the professorship of applied chemistry in the Polytechnic Institute of Zürich, directing the destinies of this department with characteristic energy, and with a success that attracted students from far and near, who sought to equip themselves for a career in industrial chemistry by a training under one who was recognised as the authority, especially in the branch of the manufacture of "heavy chemicals."

Dr. Lunge by his literary activity, as in other ways, contributed greatly to the advancement of chemical technology. His treatise on "Sulphuric Acid and Alkali," which has passed through several editions, is not only indispensable to the technologist, but is also replete with knowledge. As Mr. T. W. Stuart, himself a leader in the alkali industry in this country, and one of the few early contemporaries of Dr. Lunge, recently stated, "When you refer to these books on any obscure subject in the Alkali industry, you never go empty away, but always find in them a wealth of information."[1] A similar statement might justly be made in respect to Lunge's "Coal Tar and Ammonia," his "Technical Chemists' Handbook," and his "Handbook of Methods of Technical Gas Analysis," etc., each and all of which are essential to the equipment of the chemical technologist.

George Lunge was born at Breslau on September 15, 1839; from 1856 to 1859 he studied at the universities of Breslau and Heidelberg, graduating as Ph.D. In 1864 he came to England, with the object of obtaining technical experience. For a part of the twelve years spent in this country he was employed in the tar distillery of Messrs. Major and Co. at Wolverhampton, and in 1868 he was appointed chemist and manager to the Tyneside Alkali Company at South Shields. Dr. Lunge's efforts to obtain a footing in one or other of the twenty-six chemical works on the Tyne were at first far from encouraging, for, as Mr. Stuart tells us, a partner in one of the largest of these works offered Dr. Lunge the post of chemist at 1*l.* per week, which even at that time was but 2*s.* above the wage of a labourer! In the small works at South Shields Dr. Lunge continued until 1876, when he received the call to the chair of applied chemistry at Zürich. It is not without interest to note that his chief publications and researches deal with those phases of chemical industry, with the actual practice of which his sojourn in England had made him familiar.

At the time of his residence on Tyneside the Newcastle Chemical Society was founded, with Mr. Isaac Lowthian Bell (later Sir Lowthian Bell, Bart.) as its first president. Dr. Lunge became a member of this society, taking an active part in its proceedings and was elected president in 1872. In 1883 this society became merged into the Society of Chemical Industry and was formed into a local section of that society. However, Dr. Lunge, until the time of his death, retained his membership of the local section, using its Proceedings as the medium of publication from time to time of important scientific communications, and in many other ways evincing his sustained interest in its welfare.

The first Hurter Memorial Lecture was delivered in 1899 by Dr. Lunge before the Liverpool section of the Society of Chemical Industry, who selected for the subject of the lecture—"Impending changes in the general development of industry, and particularly the Alkali industry."

Drs. Hurter and Lunge, like many German chemists, *e.g.* Caro, Pauly, Otto Witt and others, came to England in the sixties of last century to gain a practical knowledge of British chemical industries. Dr. Hurter remained in this country and became identified with the Lancashire alkali industry, while Dr. Lunge returned to the continent, and based his teachings and writings on experience gained in the rival industry of the Tyne. Dr. Lunge had a complete command of the English language, writing and speaking it with ease and fluency. He married Miss Bowron, the daughter of a member of the firm of the owners of the Tyneside Alkali works at South Shields. P. P. B.

[1] *Chemical Trade Journal and Chemical Engineer*, January 19.

Prof. James Ritchie.

We much regret to record the death of Prof. James Ritchie, Irvine professor of bacteriology in the University of Edinburgh. Up to the end of the summer term of 1922 Prof. Ritchie carried on his work with his customary energy and zest. In the holiday which he took during August in Perthshire, however, the early symptoms of his last illness began to give anxiety, and he died on January 28.

The record of Ritchie's life shows that since he graduated in medicine in Edinburgh in 1888, at twenty-four years of age, there can have been few unoccupied hours. In 1889 a happy chance took him to Oxford to be assistant in general practice to Mr. Horatio Symonds. This post gave him a wide clinical experience, and at the same time he was able to develop his scientific bent in the laboratories of the Oxford Medical School. His mental and physical energy seemed inexhaustible. At first his available time was spent in original research in bacteriology: on the nature of bacterial toxins; the theory of germicidal action; the relation of toxic action to chemical constitution of the toxins; the reaction of immunity, etc. Following this, he undertook to teach the subject in the Medical School at the request of Sir Henry Acland, and while preparing for this he wrote, with Prof. Muir, the "Manual of Bacteriology," which was at once accepted as the standard English text-book in this subject.

After Sir John Burdon Sanderson was appointed to the Regius chair of medicine the teaching expanded into a full three terms course in pathology and bacteriology, and in 1902 Ritchie was appointed professor of pathology. In 1907 he returned to Edinburgh. As a result of his work in Oxford he had risen to the front rank in his subject. In Edinburgh he first carried on with great success the work of Superintendent of the Laboratory of the Royal College of Physicians, and in 1913 he was appointed to the newly established chair of bacteriology in the University. The Royal College, the Infirmary, and the University had endless profit from his labour.

For the interests of his subject in the medical schools of the country generally he did exceptional service as secretary of the Pathological Society, and as one of the editors of the *Journal of Pathology*. He held many offices, and his influence on the progress of medicine extended far, and in all his relations with his fellow-men his idealism and faithfulness called forth deep trust and affection. J. L. S.

Mr. W. W. Bryant.

Walter William Bryant, whose death on January 31 we much regret to record, was born on January 9, 1865, at Forthampton, near Tewkesbury, where his father was a schoolmaster. He obtained a scholarship to Pembroke College, Cambridge, and secured a first-class in the Mathematical Tripos in 1887, and a second-class in the Natural Science Tripos of 1888. He was for a short time a master at Dulwich College, and in February 1892 obtained a post as assistant at the Royal Observatory, Greenwich. His work was mainly connected with meridian astronomy. He was a most expert observer with the transit circle and was largely responsible for raising the output from 5000 to 10,000 observations. This increase in the annual number of observations remains as a permanent result of Bryant's enthusiasm. His skill and enthusiasm was also shown in observations of double stars made with the 28-inch refractor. He continued to observe regularly with this instrument till the present time.

In the year 1904 Bryant was appointed senior assistant and given the superintendence of the magnetic and meteorological department. He took up magnetic work about the time when the instruments were being set up on a new site in an enclosure in Greenwich Park. He made a large number of absolute observations, and during the war had little, if any, assistance. He took a great interest in meteorology and was for many years on the council of the Royal Meteorological Society, being secretary from 1916 to 1920, and vice-president 1920–1922. His interest in astronomy did not cease when he took up meteorology. He was a regular attendant at the meetings of the Royal Astronomical Society and the British Astronomical Association, and was the author of a "History of Astronomy," published in 1907, and of biographies of Galileo and Kepler in the "Pioneers of Science" series.

Bryant's recreations were music and hockey. He was one of the founders of the hockey club associated with the Observatory and played regularly up to 1914, and from 1919 onwards he acted frequently as referee.

Bryant married in 1894 and had ten children, of whom one died in infancy, and one was killed in Gallipoli. He was at the Observatory until within a few days of his death. His colleagues were greatly shocked by the announcement of his death following an operation. He was conscientious and industrious and a very pleasant man to work with, who will be greatly missed by his astronomical and meteorological colleagues.

Mr. T. V. Holmes.

Mr. Thomas Vincent Holmes, whose death at the age of eighty-two occurred on January 24, was for long a familiar figure in the ranks of English amateur geologists. From 1868 to 1879 he held a temporary post on the Geological Survey, when he was occupied about Carlisle and was the author of the Survey's memoir on that district; he also took part in the mapping of the Yorkshire coalfield in collaboration with the late Prof. A. H. Green, and later had similar experience in the south-eastern counties. Though Mr. Holmes so soon relinquished his official duties for a more leisured life, he maintained to the end his keen interest in local geological problems. An acute observer, he did much useful work in recording new exposures in the south-east of England, and was one of the active members of the Geologists' Association and Essex Field Club, being president of the latter in 1886–1888. He was a fellow of the Geological Society and of the Royal Anthropological Institute.

Mr. Holmes contributed a considerable number of short papers to the Association and Essex Field Club; others appear in the Transactions of the Cumberland Association and the *Essex Naturalist*. His last association with the Geological Survey was a large share in the compilation of the memoir "On Thicknesses of Strata," published in 1916.

We learn from *Science* that Dr. Fritz Wilhelm Woll, professor of animal nutrition in the University of California, died on December 6 at the age of fifty-seven. Dr. Woll was born and educated in Norway; on going to the United States, he became attached to the University of Wisconsin and was appointed assistant chemist in

1887, and later chemist, to the Wisconsin Agricultural Experimental Station. In 1906 he became professor of agricultural chemistry in the University, a post which he held until 1913, when he went to the University of California as professor of animal nutrition. Dr. Woll issued a number of valuable reports and bulletins on dairy matters and stock feeding while he was in charge of the research stations, and wrote, among other works, "A Book on Silage," "Testing Milk and its Products," and "Productive Feeding of Farm Animals," all of which have passed through several editions. According to *Science*, it was due mainly to Dr. Woll's efforts that the cow-testing associations, of so much importance to the dairy industry of California, have been developed and placed on a permanent basis.

Mr. F. E. Weston, the late head of the Chemistry Department of the Regent Street Polytechnic, died on January 4 after a long illness, and some account of his life and work appears in the *Chemical Age* of January 20. His death will be regretted by large numbers of chemists who came under his influence. Mr. Weston was the author of some sound and popular text-books, and in addition to his activities as a teacher he made several original investigations.

We regret to announce the deaths of: Prof. Wilhelm Konrad von Röntgen, at the age of seventy-seven years; Mr. Bernard Bosanquet, on February 8, in his seventy-fifth year; and Dr. A. H. Fison, lecturer on physics at Guy's Hospital, London, and secretary to the Gilchrist Educational Trust, on February 5, at the age of sixty-five years.

The *Chemiker Zeitung* of January 18 reports the death on December 6 of Prof. Luigi Marino-Zuco, of the Applied Chemistry Department of the Royal School of Engineers, Pisa.

Current Topics and Events.

The recent decision of the Commissioners of Customs to enforce payment of the entertainment tax by the Committee of the West Highland Museum at Fort William in respect of an exhibition of local objects meets with some caustic comment in the February number of the *Museums Journal*. It is pointed out that the official regulations contemplate the issue of certificates of exemption for "entertainments" of this nature, and that the Board of Education encourages such temporary local exhibitions as the best means of securing the establishment of permanent provincial museums. Thus does one Government Department hinder the efforts of the other; and thus is constructed another argument for a properly thought-out State policy towards museums.

In view of the withdrawal of oversea contributions to the Imperial Institute, a committee under the chairmanship of the Hon. W. Ormsby-Gore and including the High Commissioners of Canada, Australia, New Zealand, South Africa, and representatives of the Board of Trade, the Colonial Office, the Treasury, and the Associated Chambers of Commerce, has been appointed to investigate the position of the Institute. Mr. E. B. Boyd of the Colonial Office is acting as secretary to the committee. The terms of reference include a consideration of what functions now carried out by the Institute are considered essential and whether they should be transferred to other research organisations. Further, the committee has to consider to what extent the intentions of the founders of the Institute are being carried out and to suggest improvements which may be financially possible should it be recommended that the Institute continue on its existing basis. To us it seems astonishing that, as the Institute is largely concerned with the scientific study of the natural resources of the Empire, the committee does not include representatives of science, who alone are able to understand the significance and value of research aspects of the Institute's work.

The General Electric Co. of America has had for several years a testing transformer which can produce a potential difference of a million volts between its terminals. We understand also that Prof. Millikan will be able to experiment with a million volts at his new laboratory at Pasadena. According to *La Nature* of January 20, the Compagnie Générale d'Électro-Céramique has decided to instal a battery of transformers in its test-room at Ivry which will give a pressure of a million volts for measuring the electric strength of insulating materials. With these high pressures it is possible to make commercial tests on insulators when arranged in series, as they are on high voltage transmission lines. The Americans have also used them for testing the efficiency of lightning safety devices, and for studying the phenomena which occur when a very high voltage discharge takes place on a network.

To any one concerned with public health, and more especially to those who have witnessed the ravages of small-pox among natives in our overseas possessions and the benefits conferred by vaccination, the exhibit of pictures and relics connected with Edward Jenner now on view at the Wellcome Historical Medical Museum, 54A Wigmore Street, W., cannot fail to be of interest. Here are shown many mementoes of this illustrious benefactor of mankind; an English country doctor, blessed with unusual powers of observation and animated by a scientific spirit, whose work, despite the efforts of cranks and detractors, will stand for all time. In addition to the large number of interesting objects forming part of the Wellcome Museum, special loan exhibits are displayed. Among them is the original pencil drawing of Jenner from life executed by Thomas Drayton, while there are many rare books and the original water-colour drawings of Kirtland showing the results of vaccination and variolation from day to day. Of the lancets Jenner used there are two with ivory points similar to those on which he sent dried lymph to India. The coloured cartoon by Cruikshank entitled "The Cow-Pox Tragedy" only serves to remind us that the Jennerian method has survived the foolish and often venomous attacks made upon it for a century and more.

Several important Dinosaurian remains have lately been added to the collection exhibited in the Department of Geology in the British Museum (Natural History). A pelvis and tail of Trachodon, obtained by Mr. C. H. Sternberg from the Upper Cretaceous of Wyoming, U.S.A., have been mounted for direct comparison with the corresponding remains of Iguanodon from the Wealden of Sussex. The snout and jaws of a large Megalosaurian (Gorgosaurus), found by Mr. W. E. Cutler in the Upper Cretaceous of Alberta, Canada, have been placed close to the cast of the skull of Tyrannosaurus. The unique skull of Megalosaurus, discovered some years ago by Mr. F. L. Bradley in the Great Oolite at Minchinhampton, Gloucestershire, has been given by him to the Museum and is also now exhibited. It shows the bony core of a horn on the nose as in the American Jurassic Ceratosaurus. An interesting pelvis and femur of a small Megalosaurian found by Mr. S. L. Wood in the Lower Lias of Barrow-on-Soar, Leicestershire, and given by him, have also been mounted in the same case.

The Decimal Association directed attention recently to the handicap imposed on foreign trade by the confusion which at present exists owing to the difference—amounting to twenty per cent.—between the Imperial and the American gallons, the former having the capacity of 277·2 cubic inches while the latter is the old wine gallon of 231 cubic inches. The Association therefore suggested that the British and American Governments should abandon their existing gallons and adopt the international litre as the common unit of capacity (100 litres are equal to 22 Imperial gallons). Anglo-American uniformity and a common basis for all international trade in liquids would thus be secured simultaneously. In this connexion it is interesting to note that the American Metric Association at its annual meeting on December 30 passed the following resolution: "Be it resolved that the American Metric Association heartily approves the recommendation for the immediate adoption of the litre as the common unit of capacity, believing that this step will not only facilitate trade between the two countries, but will also constitute a common basis for international trade and good-will; and it respectfully urges the British and American Government Departments, manufacturers, and merchants to effect this desirable reform."

On February 17 occurs the bicentenary of the birth of the German astronomer Johann Tobias Mayer, who from 1754 to 1762 superintended the observatory at Göttingen. Mayer began life in a cartographer's office in Nuremberg, where he made improvements in map-making. His scientific work led to his appointment first to the chair of mathematics in Göttingen University, and then in 1754 to the charge of the observatory, which had just been furnished by George II. of England with a fine mural quadrant by Bird. Mayer's fame rests mainly on his lunar Tables, which were compared with the Greenwich observations by Bradley and Mason. Mayer died in 1762, and after his death a revised set of tables was sent by his widow to the British Government, who awarded her 3000*l*., this being a part of the 20,000*l*. offered in 1713 for a method of determining the longitude at sea. His "Theory of the Moon" and his Tables were published in London in 1770 under the editorship of Maskelyne. He also made investigations on eclipses, colours, the motion of the stars, refraction, and terrestrial magnetism. His star catalogue was revised by Baily in 1830 and again by Auvers in 1894, while in 1881 Klinkerfues published a reproduction of Mayer's fine map of the moon which for a century had remained unsurpassed.

A cablegram from Calcutta to the *Times* announces the return of Mr. Kingdon Ward from a journey of eleven months in south-western China, Chinese Tibet, and northern Burma. Mr. Ward left this country early last year and first visited Mili in western Szechuan, where he found evidence of former glaciation, which he has already described in the *Geographical Journal*. His effort to proceed from Mili directly westward was frustrated by the disturbed condition of the country, and he returned south to Likiang and went north-westward to Atuntze. Thence he crossed passes between mountains, which he reports as ranging from 20,000 to 25,000 feet in height, along the Burmese-Yunnan frontier, between Major Bailey's route into Assam and that of Prince Henri d'Orleans from Tasa on the Salween into Burma. According to suggestions previously made by Mr. Ward the mountains of the Irrawadi-Salween divide are still rising, so that their glaciers are expanding instead of being on the wane as farther to the east. Apparently, however, in this area the glaciers have also decreased in size. Mr. Ward's observations on the structure of these mountains will be of special value. His primary work is botanical, and he has discovered remarkable new species of rhododendron and primula. Mr. Ward passed a little south of the area which, according to Mr. Forrest, was the original centre of distribution of the rhododendron. A fuller account of Mr. Ward's discoveries will be awaited with great interest.

A great submarine earthquake occurred in the Pacific Ocean on February 3. As a first approximation, Prof. Turner locates the epicentre in lat. 50° N., long. 170° W., or about two hundred miles south of the Aleutian Islands. He remarks (*Times*, February 6) that other earthquakes occurred in the neighbourhood of this origin on January 30, 1914, and February 20, 1916. At Washington, D.C., and Fordham University (New York) the recording pointers of seismographs were thrown off the drums, indicating that the earthquake was one of unusual violence. Seismic sea-waves of considerable size swept over the ocean. At Hilo, in the Hawaiian Islands, which is about 2080 miles south of the origin, the waves were reported to be twelve feet in height and to have drowned several fishermen in the harbour. With the above position for the origin, it is difficult to account for the fracture near Hawaii of the cable from Midway Island to Guam, unless, as is sometimes the case, there were two separate earthquakes, one to the south of the Aleutians and the other to the west of Hawaii—a supposition which receives some confirmation from a more recent telegram (*Times*, February 9) that the origin was about 2000 miles from Samoa.

A GERMAN correspondent writes: On February 9 Dr. G. Aufschlaeger, general director of the Dynamit A.G., formerly Alfred Nobel and Co., Hamburg, celebrated his seventieth birthday. Dr. Aufschlaeger was born at Jahnishausen, Saxony, graduated at Heidelberg and then became assistant lecturer at the Technical High School of Dresden. In 1882 he founded the dynamite factory of Muldenhütten, which was combined in 1884 with the dynamite works of Dresden; and in 1889 he became general director of the dynamite factory founded in 1864 by Alfred Nobel in Hamburg. Here he displayed an activity which was of the greatest importance for the whole industry of explosives. He brought about the combination of the principal German dynamite works and their co-operation with the chief foreign representatives of the industry. As the patents of Nobel for the manufacture of gelatin-dynamite from nitroglycerin and nitrocellulose, which belonged to his company, initiated a new epoch in the production of smokeless powder, he also succeeded in forming a syndicate with the manufacturers of gunpowder. This co-operation was of the highest importance technically, as it rendered possible the widespread distribution of new inventions and improvements. For the purpose of testing new inventions the scientific technical central offices in Neubabelsberg near Berlin were founded. In the construction of explosives works Dr. Aufschlaeger directed his attention towards securing the isolation of possible explosions and preventing their spread to other parts of the buildings. At the present time he is endeavouring to utilise the plant of the explosives works for peaceful purposes. "Vistra-wool," a substitute for cotton, produced from wood, is being manufactured by one of the dynamite works, and has been highly praised by experts.

IT is announced in the *Times* that in celebration of the 450th anniversary of the birth of the Polish astronomer Copernicus on February 19, a memorial tablet will be unveiled and a municipal scientific library bearing his name will be opened in his native town of Thorn.

THE new Research Laboratories of the General Electric Co., Ltd., Wembley, will be opened on Tuesday, February 27, at 2.30 P.M., when Lord Robert Cecil and Sir Joseph Thomson will deliver inaugural addresses.

THE annual lecture to the London Graduates' Section of the Institution of Mechanical Engineers will be delivered at 7 o'clock on Monday, February 26, by Prof. E. G. Coker, who will speak on "Photo-elastimetric Researches on Mechanical Engineering Problems."

WE notice in the programme of lectures for 1922–1923 of the Franklin Institute, Philadelphia, Pennsylvania, that Dr. Walter Rosenhain is lecturing to the Institute on the structure and constitution of alloys, and that in April Sir Joseph Thomson is to deliver a course of five lectures at Philadelphia on the electron in chemistry.

MAJ.-GEN. SIR FREDERICK B. MAURICE, Dr. Alexander Scott, and Prof. A. N. Whitehead have been elected members of the Athenæum Club under the provisions of the rule of the Club which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

THE following officers and members of council of the Royal Astronomical Society were elected at the anniversary meeting held on February 9:—*President*: Dr. J. L. E. Dreyer. *Vice-Presidents*: Prof. A. S. Eddington, Sir F. W. Dyson, Mr. E. B. Knobel, and Prof. H. F. Newall. *Treasurer*: Lieut.-Col. F. J. M. Stratton. *Secretaries*: Mr. H. Spencer Jones and Rev. T. E. R. Phillips. *Foreign Secretary*: Prof. H. H. Turner. *Council*: Prof. A. E. Conrady, Dr. A. C. D. Crommelin, Mr. C. R. Davidson, Prof. A. Fowler, Dr. J. W. L. Glaisher, Mr. P. H. Hepburn, Mr. J. Jackson, Dr. Harold Jeffreys, Prof. F. A. Lindemann, Mr. E. A. Milne, Dr. J. W. Nicholson, and Mr. J. H. Reynolds.

WE have received an address on advances in the metallurgy of iron and steel, delivered by Sir Robert Hadfield before the Cambridge University Engineering Society on January 25. The address, which was illustrated at the time by means of kinematograph and lantern slides and exhibits, ranges over a wide field, its subject being the importance of metallurgical discoveries to modern engineering. The scientific record of Cambridge and its school of engineering is taken as a text for a discourse on the technical applications of science, with special reference to motor-car engineering. In this connexion many passages are quoted and commented on from the recent autobiography of Mr. Henry Ford. An opportunity is taken to point out the exaggerated impression of German supremacy in chemical science which has been caused by our dependence on German text-books, and to urge that more attention should be given to the production of scientific compendia in the English language, and free from undue national bias. The address, which breathes a spirit of scientific enthusiasm, contains some interesting incidental notes on armour-piercing projectiles and similar subjects on which the author speaks with authority.

ACCORDING to the fourth annual report of the Scientific Instrument Research Association, the period for which Government grants on the present scale were guaranteed expires on June 30, but as there is in the case of the Association an unexpended balance sufficient to maintain the work for a sixth year, the Department of Scientific and Industrial Research has extended the period of the grant to June 30, 1924.

During the year 1921–1922 covered by the report, the Association has been engaged on researches on neutral, optical, and coloured glasses, on abrasives and cements for optical work, on the durability of glass, on phosphorescent material for X-ray use, on greases and wax mixtures, on lacquer, on the best wave for generation of X-rays, on regulation and focussing of X-ray tubes, on insulators, manganin wire, and on galvanometer coils. The work already done by the Association is bearing fruit, and firms engaged in instrument making are finding that the saving in their working costs owing to the adoption of methods suggested by the Association thoroughly justifies their financial support of it. We are glad to be assured that steps are being taken to secure from the industry adequate means to continue the work of the Association after the close of the Government grant period in June 1924.

WE regret that a manuscript note on the corner of the first part of the *Zeitschrift für angewandte Geophysik* led the reviewer in our issue of February 3, p. 145, into stating that the price of the single part was 20s. The publishers, Gebrüder Borntraeger, have pointed out that this sum covers the whole of the first volume, and we hasten to make this correction in the interests of a publication which they have undertaken with their characteristic enterprise.

MESSRS. LONGMANS AND CO. have nearly ready for publication "Synthetic Colouring Matters: Vat Colours," by Prof. J. F. Thorpe and Dr. C. K. Ingold. It will deal with the history of vat dyeing, of synthetic indigo and the various analogues of indigo; the derivatives of anthraquinone, and the preparation of some of the vat colouring matters. Another book to be published soon by the same house is "Printing Telegraph Systems and Mechanisms," by H. H. Harrison, a text-book intended for the use of the designer, the administration official, the technical telegraphist, and the student of telegraph matters.

A NEW departure in the policy of the American Chemical Society is evidenced by the appearance (through The Chemical Catalog Co., Inc., New York), of a number of monographs on various branches of chemical science and the issue of a long list of projected volumes. The series is announced as "a serious attempt to found an American chemical literature without primary regard to commercial considerations." Among the monographs in preparation are: Shale Oil; Coal Carbonisation; Aluminothermic Reduction of Metals; The Chemistry of Leather Manufacture; Liquid Ammonia as a Solvent; Wood Distillation; Thyroxin; Extraction of Gasoline from Natural Gas; Refining Petroleum; The Structure of Crystals; The Properties of Metallic Substances; Solubility; Valence, and the Structure of Atoms and Molecules; Organic Arsenical Compounds; Absorptive Carbon; Chemistry of Cellulose; The Properties of Silica and the Silicates; Piezo-Chemistry; The Animal as a Converter; Cyanamide; The Corrosion of Alloys.

Our Astronomical Column.

THE GREAT RED SPOT ON JUPITER.—Mr. W. F. Denning writes:—The planet Jupiter is now coming well into view and will rise at about midnight at the end of February. The Great Red Spot which has been certainly visible, though under rather different aspects, since 1857, is still to be distinguished.

It should be observed as often as possible during the ensuing spring months, and the times of its transit across the central meridian carefully recorded. Its rate of motion last year indicated a period of rotation equal to $9^h\ 55^m\ 38^s$. During the last few years the spot has exhibited a slackening of velocity. As a guide to telescopic observers the following times are given when this marking will be on or near the central meridian:—

	h.	m.		h.	m.
March 6 .	14	29	March 16 .	12	40
,, 8 .	16	7	,, 18 .	14	18
,, 10 .	17	45	,, 28 .	12	30

At the present time the spot precedes the zero meridian (of System II.) by about $3\frac{1}{2}$ hours, and this is increasing. There is another long, dusky marking in nearly the same latitude of Jupiter which closely follows the eastern end of the Red Spot. This will also well repay observation. It has been visible since 1901.

PERIODIC MOTION IN THE THREE-BODY PROBLEM.—Prof. Strömgren gives in No. 39 of the publications of the Copenhagen observatory a useful summary of the progress attained in recent years in the studies made there both in the restricted and the general problem of 3-bodies. (The former supposes one body infinitesimal, and the motion of the other two bodies circular.) The method used is that of mechanical quadratures, which is tedious and needs many successive approximations before periodic orbits are found, but it has the advantage of avoiding the mathematical difficulties involved in theoretical work.

The pamphlet also summarises the work of Sir G. Darwin and others. The connexions between families of orbits are traced, and it is considered that the treatment of the restricted problem with the selected mass-ratio is approximately complete. The orbits are divided into 16 classes comprising libration orbits about the 5 equilibrium points, 3 of which are in the line joining the finite masses, the other 2 are the equilateral-triangle points, which were at first merely theoretical, but later found exemplification in the Trojan group of minor planets.

The results illustrate various possibilities in the case of planets moving about a pair of suns. Each sun might have some satellites peculiar to itself, their motion, like that of our moon, being somewhat disturbed by the other. A figure-of-eight, encircling each sun in turn, is another possibility, while other orbs might pur. ue large orbits, in the form of distorted ellipses, outside both suns. But it must be remembered that periodic motion requires an exact adjustment of the initial speed and direction of motion. In most cases the orbits would not be periodic at all, but would undergo changes from one type to another.

A beginning has now been made with the study of the motion with all three masses finite. The case first studied was that of small librations about the 3 equilibrium points in a rotating line. This was subsequently extended to orbits of ejection or collision, in which 2 of the bodies are together at the beginning or end of the time considered. A case of 4-body libration is also sketched. No. 40 of the Copenhagen Publications deals with a special case of the 4-body problem, with 3 equal masses in a line, and the fourth infinitesimal.

Research Items.

THE SIKHS OF THE PUNJAB.—The present agitation among the Sikhs of the Punjab is critically discussed by a well-informed writer in the February issue of the *Fortnightly Review*. He points out that numerically the Sikhs constitute only 12 per cent. of the population of the Province, as compared with 51 per cent. Muslims and 36 per cent. Hindus, and that the revival of Sikhism in the period before the war was largely due to its encouragement by the British officers in Sikh regiments. The Sikh, by his aptitude for emigration, is much more open to foreign influences than the stay-at-home Hindu, and after the war he has suffered from a "swelled head." The recent agitation has centred round the management of the Gurudwaras or religious foundations, some of which fell into the hands of ill-conducted Mahants or Abbots, and has been favoured by the influence of outside agitation. We cannot enter into a discussion of the proposals the writer suggests for the control of the agitation and the redress of legitimate grievances. But as an episode in the history of one of the leading fighting races of India we may direct attention to this comprehensive review of a situation which, if not dealt with in a statesman-like way, may have serious consequences.

THE PLUNDERING OF ROYAL EGYPTIAN TOMBS.—While the recent wonderful discoveries in Egypt are engrossing public attention two writers in the February issue of *Discovery* have thrown welcome light on the subject. In the first article Prof. T. E. Peet tells us the little that is known of the history of King Tutankhamen, really a series of inferences from archæological remains. In the second article Dr. A. M. Blackman tells the strange tale of the plundering of the Royal Tombs at Thebes in the XXth and XXIst dynasties, as recorded in the Abbott Papyrus preserved in the British Museum, with sidelights from two Meyer Papyri, now at Liverpool, recently published with a translation and notes by Prof. Peet. In spite of the tragical course of the inquiry which followed the outrage and the horrible examination of the criminals by torture, the tale of the rivalry of the two Mayors, Peser and Pewer'ō, governors respectively of eastern and western Thebes, is graphic and characteristic: Peser acquired information of the robbery and thought it a good opportunity to pay off old scores against his hated rival, who was responsible for the protection of the royal sepulchres. Pewer'ō ultimately was discharged, but we may reasonably suspect that the charges were anything but groundless, and that the truth of them was being gradually forced on the Vizier Khamwesē who conducted the inquiry. In fact, it would seem that the maladministration of the necropolis had become so notorious that even heavy bribes could no longer make it worth the Vizier's while to continue his policy of hush. The tale, as a whole, shows that human nature in Egypt is now much the same as it was three thousand years ago.

SARSEN STONES.—The origin of the name given to these stones in the central region of the English Chalk seems still in doubt, but Sarsden village, near Andover, has been suggested as a possibility. The grey sandstone of which sarsens are composed is widely known through its use at Stonehenge; but the original bed in the Eocene series seems to have been completely broken up by denudation. The sarsens lie as relics on the surface, with detrital deposits worn from the Eocene strata and the Chalk, and an instructive photograph has now appeared in the Geological Survey Memoir on the country around Beaconsfield (Ordnance Survey, 1922, price 2s.). Here we are shown great blocks lying in the "clay-with-flints" of Buckinghamshire, and we learn that the stones are sought for by boring in the hope that the tool will strike on one. Following prehistoric practice, the builders of Windsor Castle gathered sarsens, and they are still the only useful stone to be found in the Beaconsfield district.

CITRUS FRUIT FROM SOUTH AFRICA.—Investigations on waste in export citrus fruit were carried out by Miss Thomson, and Messrs. Putterill and Hobson, during 1920 and were continued during 1921, and the results are embodied in a report, Bull. No. 1, 1922, Union of S. Africa, Dep. of Agriculture, Pretoria, 1922. Care in handling is perhaps the principal factor upon which elimination of waste depends. The slightest damage in packing or in the subsequent handling of the cases tends to induce discoloration and the development of moulds which spoil the fruit. Cargoes can be successfully shipped to this country not only in cold storage, but also in holds without cold storage provided they be properly ventilated and the fruit undamaged. Proper wrapping of the fruit in special wax tissue wrappers reduces wilting considerably. The best cold storage temperature lies between 43° and 50° F. Change in flavour is particularly induced by a temperature below 40° F., probably by killing the cells, thus allowing the acrid-tasting constituents of the skin to penetrate to the juicy part of the fruit.

BRITISH MYCOLOGY.—Volume 8, Parts I. and II. of the Transactions of the British Mycological Society contains Mr. Carleton Rea's presidential address; the views expressed by Mr. Rea as to the value of certain continental revisions of the systematic arrangement of the larger fungi will carry very great weight and, in the future, the microscope will certainly figure more prominently in the work of British mycologists. J. Line shows good reasons for regarding with suspicion the advent of the well-known "coral spot" fungus, *Nectria cinnabarina*, among a plantation of pruned red currants; the fungus apparently spreads slowly from dead spurs into the healthy tissues with disastrous effects ultimately. The paper by J. Ramsbottom upon orchid mycorhiza is reprinted in full from Messrs. Charlesworth and Co.'s catalogue; it is a scientific contribution of very general interest and at the same time a tribute to the memory of a remarkable orchid grower, the late Mr. Joseph Charlesworth. Among other papers should be noted Dr. M. C. Rayner's critical analysis of the claim recently made by Christoph to have raised healthy Colluna seedlings free from mycorhizal infection. W. B. Crow's account of that curious bacterial organism *Leuconostoc mesenteroides* is an interesting example of the significance that may attach in classification to the chemical constitution of a plant membrane: another step towards the distant day when chemical knowledge may be freely used to underpin the elaborate framework erected by the systematist.

BROWN BAST DISEASE OF RUBBER TREES.—A. Sharples has recently published (*Malayan Agricultural Journal*, vol. x. No. 6, June 1922) a résumé of recent experimental work in Malaya upon this problem, which is perhaps less urgent for the moment as the industrial depression has decreased the demand for rubber, and the one fact that seems firmly established in connexion with this disease is that its spread coincides with efforts to get more latex from the trees. Sharples chronicles briefly the progress of investigations promoted by a representative Brown Bast Investigation committee formed in Malaya in 1918, but owing to changes of personnel this committee appears to have ceased to function in 1920 although investigations still proceeded. He also passes in critical review a number of papers recently published on the subject which were also noticed in Nature for March 16, 1922 (vol. 109, p. 357). One general result of the investigations under the auspices of the committee is to strengthen the conclusion, also reached by Rands in Java, that while various organisms may be casually connected with the disease, none can be considered causal and the disease must apparently be definitely added to the list of pathological physiological conditions of obscure origin. In view of confident assertions by Keuchenius in Sumatra that bacterial inoculations produced a similar disease, this conclusion was very critically re-examined and comparative inoculations made with the organism used in Sumatra; the evidence against bacterial causation thus accumulated is very convincing. On the other hand, the Malayan experiments supply further experimental evidence that increased tapping of the latex, either by more frequent incision or by a wider cut, greatly increases the percentage of trees attacked by brown bast. Sharples reviews recent suggestions that various anatomical peculiarities may throw light upon the pathology of the disease. He regards the pockets of laticiferous tissues enclosed within wound cork, recorded by Sanderson and Sutcliffe, as after-effects of little value in elucidating the causes of the disease, and he points out that lignification and necrosis of sieve-tubes, such as is recorded by Farmer and Horne, may frequently be seen in perfectly healthy plants.

Rainfall in 1922.—The British Rainfall Organization, which now forms a part of the Meteorological Office, Air Ministry, has made a hurried scrutiny of the rainfall records for 1922 in time for insertion in the *Meteorological Magazine* for January, which is published in the middle of the month. Several thousand returns are said to have been already received and a selection has been made of those for which average returns exist; 280 such records have been examined and they afford sufficient data for the construction of a rainfall map. The rainfall for the individual months shows that the rain over the country as a whole was close to or above the average except in the autumn. The total was excessive over England in July, yielding locally more than double the average. October was exceptionally dry, the rainfall being in England and Wales 33 per cent. of the normal, in Scotland 59, and in Ireland 37 per cent. In England and Wales the only months with a deficiency of rain were May, June, October, and November. In Scotland there were six months with an excess and six months with a deficiency, the first seven months being wet with the exception of March. In Ireland there were only five months with a deficiency of rain; these were March, May, June, October, and November. The country as a whole had practically the normal fall for the year. The *Times* for January 29 had a detailed article on the rainfall of the past year, in agreement with its practice followed for many years past. It shows that 1922 was almost entirely devoid of remarkable features. Among the selection of records available the variations of rainfall registered in 1922 ranged from 115·25 in. at Seathwaite to 18·66 in. at Shoeburyness. The map giving the rainfall over the British Isles shows that there was a general deficiency of rain in Scotland and Ireland and a general excess over England, although in the extreme south-east, where the drought of 1921 reached its climax, the rainfall of 1922 was again below the average; but the deficiency apparently nowhere exceeded 10 per cent. The date given at head of Table II. for all columns except the average should be 1922 and not 1921.

Recent Volcanic Activity in S. Africa.—Dr. P. A. Wagner has written a very thorough and interesting memoir on "The Pretoria Salt-pan, a soda caldera," for the Geological Survey of S. Africa (Mem. No. 20, 1922, price 7s. 6d.). A saline lake some 25 miles north-west of Pretoria has long been used by natives as a source of common salt, and in recent years it has been worked on a commercial scale on account of the sodium carbonate in its waters. Excellent photographs are given of this *zoutpan* in its primitive and its industrialised conditions; but the most interesting of the numerous illustrations are those showing the form and the walls of the depression in which it lies. The author proves clearly that we are here dealing with a true caldera of explosion. If at any time a layer of volcanic scoriae covered the broad cone of eruption, all traces have disappeared through denudation. It is far more probable that the walls were built up entirely of fragments exploded from the granite and dolomite that underlie the area. Their structure is seen in a number of cliff-sections, and the freshness of the whole ring suggests a Quaternary age for the paroxysm that actually domed up the granite cover and flung the fragments for 1700 feet on all sides from the central pipe. The perimeter of the caldera measures 11,100 feet. The saline layers from which the soda is mainly derived are a trona bed above and a bed of the rarer carbonate, gaylussite, in the muds below. There is a remarkable absence of sodium sulphate. Dr. Wagner gives good reasons for regarding the salts as of magmatic origin. Now that a kimberlite pipe in the Cape Province has been proved to be of post-Neocomian age (see Nature, vol. 110, August 19, 1922, p. 262), evidence of volcanic outbreaks linking the southern region with the still active areas near the great lakes will be sought for with a lively interest. Folding sections and a map on a large scale accompany this comprehensive memoir.

Palæobotany and the Gondwana Continent.—Recent contributions to palæobotany will be found in the Quarterly Journal of the Geological Society, vol. 78, Part 3, where Prof. A. C. Seward describes carboniferous plants from Peru (pp. 278-83), and Seward and R. E. Holttum report upon Jurassic plants from Ceylon (pp. 271-77); and in the *Geological Magazine* (vol. 59, pp. 385-92, September 1922) Prof. Seward has a note upon fossil plants from the Tanganyika Territory. Dr. A. B. Walkom (Queensland Geological Survey Publication, No. 270) has recently commenced the publication of a monograph upon the Palæozoic Flora of Queensland, while the general issues and problems of distribution and of plant migration across regions of the globe that at the present day provide impassible oceanic or climatic barriers is raised by Prof. Seward in the Hooker lecture published in the Linnean Society's Journal for October 1922. These new palæobotanical data recorded above supply more facts for land areas that presumably were organically linked in Mesozoic times through the great Gondwana continent of which India now remains one of our most authentic relics. It is therefore interesting to note, from the address of Prof. B. Sahni delivered at the Indian Science Congress in 1921 (Journal and Proceedings of the Asiatic Society of Bengal, vol. 17, No. 4, pp. 152-75), that Indian botanists are taking an interest in the Indian fossil flora, as yet but little explored since the earlier work of Feistmantel, embodied in the "Fossil Flora of the Gondwana System." Prof. Sahni points out that so far Indian strata have given little but plant impressions, but with the recent microchemical methods for the microscopic study of such impressions, developed in the Cambridge laboratories and demonstrated by Mr. J. Walton at the British Association Meetings at Hull, fossil impressions may become as valuable and as definite in the results they yield as the plant petrifactions permitting anatomical study.

MEASUREMENT OF VERTICAL DIMENSIONS WITH MICROSCOPE.—In the Journal of the Quekett Microscopical Club (Ser. 2, vol. 14, No. 88, November 1922) Mr. F. Addey gives a note on the measurement of the vertical dimensions of objects by the use of the graduated fine adjustment, in which he shows from mathematical considerations that the true thickness of the object is its apparent thickness multiplied by the refractive index of the mounting medium, the cover glass making no difference. This result has been confirmed by actual measurements.

FOCUS APERTURE RATIOS OF MICROSCOPE OBJECTIVES.—In the Journal of the Quekett Microscopical Club (Ser. 2, vol. 14, No. 88, November 1922) Mr. E. M. Nelson discusses the focus aperture ratios of microscope objectives. If the values of the numerical apertures of objectives now available be plotted against the magnifying powers the resulting graph reveals several inconsistencies. In the present paper a new set of power aperture curves drawn up on a definite plan are given for the construction of objectives. The ideal value for the power aperture ratio, obtained from a consideration of the resolving power of the eye, cannot always be realised in practice. This ideal ratio expressed as an "optical index" (that is 1000 times the N.A. divided by the initial magnifying power) is shown to be 25, and in the proposed curve for achromats the low powers up to $\frac{4}{10}$ in. have an optical index of 20, after which the optical index is reduced and the curve becomes steeper, rising to a $\frac{1}{5}$ in. with N.A. 0·9. In the apochromats the optical index in the curve is maintained at 20 up to a N.A. of 0·8. For oil immersion lenses the optical indexes have to be reduced, and the proposed curve begins with a $\frac{1}{7}$ in. of N.A. 1·0 (optical index 14·3) and ends with a $\frac{1}{12}$ in. of N.A. 1·4 (optical index 11·7). If such schemes of ratios of aperture to power were adopted the initial magnifying power and the numerical aperture would become practically synonymous terms and a lens could then be accurately designated by its numerical aperture instead of by the focus, thus avoiding ambiguity where different tube lengths are used.

CONTACT CATALYSIS.—No. 30 of the Reprint and Circular Series of the National Research Council contains the first report of the committee on Contact Catalysis. The report, which has been drawn up by Prof. Bancroft, gives a summary of recent work and suggests that the two fundamental things to be done in the study of contact catalysis are: (1) To determine in what cases definite intermediate compounds are formed and what they are; (2) To determine what bonds and contravalences are opened when adsorption takes place, and to show that the opening of these bonds and contravalences accounts for the formation of the reaction products.

BACTERIA AND CONDENSER CORROSION.—An investigation on the influence of the fermentation products of bacteria on corrosion in engine condensers, conducted by Messrs R. Grant, E. Bate, and W. H. Myers, originated during the systematic examination of possible factors in the causation of corrosion, particularly pit-hole corrosion, in condensers of two power-houses of the Government Railways and Tramways, Sydney, N.S.W. (Rep. of the Director-General of Public Health, N.S.W., for the year 1920, Sydney, 1922, p. 171). It had been noticed that tube failures often occur after a long period of shut-down, even when a condenser has previously been immune from trouble. The authors point out that condensers generally retain a considerable quantity of water, complete drainage never being obtained with the usual horizontal setting. This stagnant water always contains a very high proportion of free and albumenoid ammonia and nitrates. Various micro-organisms of ammonia-producing types were isolated from the circulating and stagnant waters of condensers. Plates of copper, brass, and zinc introduced into cultivations of these organisms underwent corrosion and pitting, photographs of which are reproduced. It is concluded, therefore, that the activity of micro-organisms as a factor in starting or causing corrosion must be seriously considered. If corrosion were a purely thermal or chemical effect, the pitting might be expected to increase steadily with temperature; actually, it is found to be more in evidence in low temperature condensers, which supports the micro-organismal theory.

FRENCH STREAM GAUGING APPARATUS.—In a notice recently issued from the gauging station of the University of Toulouse at Ponts-Jumeaux, a description is given of the log used by the French Service des Forces hydrauliques and the method of calibration adopted. The log is essentially a screw of a special form, attached to a revolving axis mounted on ball-bearings in the body of the log. The apparatus is designed in such a way that the axis lies in the direction of the current, and the screw encounters the liquid filaments in front. The relationship between the rotations n of the screw and the velocity v of the water is in the following form: $v=a+bn$. The determination of the speed of the screw in revolutions per second is carried out as follows. The axis of the screw engages by a worm in a cogged wheel, designed so that the screw makes N revolutions for a single revolution of the cogged wheel. This number, N, is fixed for any particular log and is generally equal to 25 or 50. A cam carried by the cogged wheel comes in contact at a fixed point of each turn with a spring plate connected with an insulated electric terminal on the body of the apparatus and thus closes an electric circuit actuating a bell. By measuring the time T, which passes between two consecutive signals, there is deduced therefrom the number of revolutions of the screw per second ($n=N/T$) and the movement of the water can be calculated. The coefficients a and b are determined in the process of calibration. For the purpose of calibrating the apparatus, a carriage with a platform is propelled at a certain speed while the instrument it supports is drawn through still water. During a sufficiently long series of runs, the speed of the carriage is related to the number of revolutions of the screw, and a curve, which is generally a straight line, can be drawn. A cement-lined channel 75 metres long, 2 metres wide, and 1 metre deep is used for calibration.

The Conduction of Excitation in Mimosa.

THE problem of the conduction of excitation in organisms is one that concerns both plant and animal physiologists, and any advances in our understanding of conduction in either kingdom should be of common interest to all. Yet certain recent discoveries concerning excitatory conduction in plants have so far not become very widely known.

The problem comprises essentially two questions: first, what is the nature of the excitation itself? and secondly, how is excitation at one point in an organ able to lead in turn to excitation at a neighbouring point? As to the first, there may perhaps be indications that excitation is something fundamentally similar in all protoplasm; but as to the second, it may well be that the link connecting the excitation of one point with that of the next is quite different in the case of different organs. In one case the nature of the link seems now to be well established—namely, in the case of species of the "sensitive" genus Mimosa, on which Dr. U. Ricca[1] has carried out a remarkable series of experiments.

As is well known, the spread of excitation in these plants is revealed mainly by the fall of the main petiole of the doubly compound leaf, the forward movements of the secondary petioles, and the folding together upwards in pairs of the leaflets. These movements can be brought about by injuring a leaflet, and also by inflicting cuts or burns on the main stem of the plant, which may lead to the spread of excitation along the stem and out over several leaves. It is principally on this conduction in the stem that Ricca has experimented.

The starting-point of his work is the proof that, as maintained long ago by Dutrochet, the path of conduction is the wood and not the phloem or cortex. To establish this he has made use, not of the well-known *Mimosa pudica*, but of *Mimosa Sepzazzinii*, in which it is possible to remove completely, in a ring round the stem, the tissues external to the cambium, thus laying bare the wood.

Such ringing does not prevent the excitation from passing, as is shown by the closure of the leaflets in the leaves above the ringed zone, after a part of the stem below the ring has been stimulated by cauterisation. Conduction can therefore take place without cortex. Further, by removing one longitudinal half of the stem and then, in the remaining half, prising off the extra-cambial tissues from the wood, he has been able to investigate the effects of stimulating the two separately. Stimulation of the strip of wood leads to movements in the leaves above, even after the pith has been scraped away, whereas stimulation of the strip of phloem and cortex does not. Since the latter are known not to be insensitive to stimulus, it follows that they must be unable alone to conduct the excitation effectively.

Next Ricca confirms the fact, already known, that conduction can pass through a zone of the stem that has been completely killed by heat, and he also shows that even when a zone of 4-5 cm. is maintained at a temperature above 150° F. this does not prevent the supply of water to the leaves above, nor the conduction of excitation. Going further, he divides the stem transversely and inserts the cut ends into the expanded ends of a narrow glass tube 8 cm. long and 1 mm. in diameter. An earlier experiment with a wider tube (1916, "a," p. 94) is less convincing. Cauterisation of the stem below the tube was followed by closure of the leaflets above it; and if the stimulus was strong, a greenish substance was seen to issue from the lower cut end, and slowly to spread up the tube. The time taken by the coloration to spread agreed roughly with the time apparently taken by the excitation to pass the tube (see schedules, *loc. cit.*, p. 110 *sq.*).

Already these results suggested that conduction takes place by the transference of a soluble stimulating substance excreted by the stimulated cells; for increase of permeability and excretion of liquid is known to accompany excitation in Mimosa and other plants. The final experiment in confirmation of this was the extraction of the substance by preparing in a small quantity of water a large number of transverse sections of stem. Other cut branches were then placed with their cut ends in the liquid thus obtained, and thereby excitation was found to be set up in them and to spread gradually up from the cut end towards the apex, as shown by the successive movements of their leaves.

It seems clear then that conduction both in the glass tube and in the wood of the plant must be brought about by the movement of a stimulating substance with the water current. It cannot be due to pressure changes; first, because it is too slow (in one case 55 cm. in 1¼ hours: average values for *M. pudica* are 8-15 mm. per sec. in the petiole and 2-3 mm. per sec. in the stem); and secondly, artificial changes in pressure of the water-supply to cut branches were not found to result in stimulation.

In agreement with this, factors increasing transpiration and so accelerating the ascent of water in the stem were found to increase the rate of conduction. Still, it may remain uncertain whether movements of the water current alone can account for all cases of conduction in these plants, particularly for basipetal conduction in the leaves. In *Mimosa Spezazzinii* this takes place only with difficulty, and Ricca considers it due to the excretion of liquid from the stimulated region, which is then sucked away in both directions by neighbouring unstimulated tissues. In *Mimosa pudica* basipetal conduction takes place rapidly and easily. Possibly the activity of other living tissues along the conducting zone may in some cases be involved, even if it is not necessary for conduction in the stem. It is also desirable that the results should be confirmed by other workers in warm countries.

Comparison may be made with the conduction of excitation in the cotyledon of a grass seedling, which also seems to involve a stimulating substance. In this organ, various stimuli, striking on the tip alone, bring about a responsive curvature in the elongating region below. The excitation conducted from tip to responding region can pass through a layer of gelatin, after the tip has been cut off and stuck on again.[2] It appears that Stark (*loc. cit.*) has extracted the stimulating substance concerned. An excitatory process capable of passing through gelatin has also been found by the present writer in roots.

But in these cases the mechanism of conduction in the tissues is still obscure, and probably different from that found in Mimosa. It appears that conduction may here take place in parenchymatous tissues, and it is checked by local application of anæsthetics and other physiological agents.

R. SNOW.

[1] Ricca, U., "Soluzione d' un problema di fisiologia," *Nuovo Giorn. Bot. Ital.* 23, 1916, "a."
"Solution d'un problème de physiologie," *Archives italiennes de Biologie*, 65, 1916, "b."

[2] Boysen-Jensen. Ber. d. D. Bot. Ges., 31. p. 559. 1913. Páal, *Jahrb. f. wiss. Bot.* 58, 1918. Stark, *Jahrb. f. wiss. Bot.* 60, 1921.

The Third Air Conference.

By Prof. L. BAIRSTOW, F.R.S.

THE Air Conference at the Guildhall, London, occupied four sessions — the mornings and afternoons of February 6 and 7—the first day being devoted to the reading of papers, and the second to their discussion. Of the papers read, that of greatest interest to men of science was by Sir Geoffrey Salmond, the Air Member for Supply and Research on the Air Council, on " The Progress of Research and Experiment." Before referring to this paper and the subsequent discussion, it is desirable to note some of the points made by Sir Samuel Hoare, the Secretary of State for Air, who spoke immediately after the opening ceremony by the Lord Mayor of London.

It was pointed out that the new Air Ministry had only been in office for three months and that the time had been all too short for the determination of a fixed policy. Later speakers emphasised the importance of the earliest possible declaration of policy, and were not wholly inclined to agree that, so long as the world is in a state of confusion and uncertainty, military aviation must have the first and principal call on the nation's purse. It was argued that civil aviation will have the same relation to the Air Force as the mercantile marine has to the Navy, and that the most economical expenditure of money would lead to a rearrangement of the vote so as to give a greater share to the commercial aspect.

It was argued by one speaker that private enterprise would be ready to find the capital for aerial transport when once it felt certain of a continuous and sympathetic policy on the part of the Air Ministry. The Secretary of State for Air had previously said that he was trying to develop a consistent civil aviation policy, and for weeks past had been considering schemes for its organic development.

The Conference was assured that the Air Ministry fully realised the importance of research and was anxious to foster it within the limitations imposed by finance. It is necessary to bear in mind the fact that the word " research " does not mean the same thing to all men, but in the sense in which that word is understood by men of science, there is a marked improvement in policy. It may be some time before the effects of the change are evident in results, for we have fallen on evil days, but it is to the good that the tide has ceased to ebb.

The Air Ministry organisation was described by the Air Member for Supply and Research in his opening paragraphs. He said : " Perhaps I may be forgiven if I describe to you our organisation for research, as I fear it is sometimes misunderstood. In the first place, there is the Air Ministry charged with the general direction of research. The Air Ministry is advised by the Aeronautical Research Committee, either on the initiative of the Air Ministry or on the initiative of the Aeronautical Research Committee, as to the problems to be solved, or as to the methods by which they should be solved. A representative of the Aeronautical Research Committee works in the Air Ministry and has direct access to me on all questions.

" The Aeronautical Research Committee does invaluable work in investigating all sorts of problems, and is wonderfully assisted in its work by the National Physical Laboratory and a whole body of scientists who give their services free to the nation, as well as by the great universities and consulting engineers.

" These organisations deal with the theoretical solution of air problems in the domain of pure research. But research cannot stop here ; its practical application has to be considered, and this portion of the work is carried out by the Royal Aircraft Establishment at Farnborough and various experimental stations such as the Aircraft Experimental Establishment at Martlesham, and the Marine and Armament Experimental Establishment, Isle of Grain.

" A third organisation also exists, and that is the Aircraft and Aero-engine Constructors, who maintain most capable designing staffs who constantly bring forward solutions of problems, which enable us to step forward. I would be failing in my duty if I did not here acknowledge the debt this country owes to all these organisations, the joint efforts of which have undoubtedly brought our world position as regards research to a position second to none."

This constitutes the clearest statement of the organisation yet given, and it will be obvious to readers of NATURE that research as defined by the Air Member for Supply and Research has a much wider range than research as understood by men of science. In his interpretation, all technical development and experiment is included, and there is an absence of recognition of the usual criterion as to the fundamental or specific nature of the inquiry. It is in conformity with this definition that the Director of Research in the Air Ministry has wholly different functions from the Director of Scientific Research in the Admiralty. With adequate subdivision of funds and duties the matter of definition is unimportant, although the effect is the nominal allocation of a large sum for research, while in fact only a small fraction is devoted to scientific operations. There are marked indications of a welcome change, and that the advice of the Aeronautical Research Committee as to need for greater attention to fundamental inquiries is being acted on.

Sir Richard Glazebrook, chairman of the Aeronautical Research Committee, made during the Conference a special appeal for fundamental research, giving as subjects the study of the motion of viscous fluids from first principles, the provision for full scale research on airships should these again come into operation, and the study of the motion of aeroplanes in flight. All these forms of inquiry are greatly assisted by laboratory experiments and wind channel tests on models of aircraft.

The mathematical treatment of viscous fluid motion has not hitherto received any direct recognition by the Air Ministry, although the programme of the Aeronautical Research Committee leaves an opening for the staff of the National Physical Laboratory. The inquiry is, however, being fostered by the Department of Scientific and Industrial Research, and by the governors of the Imperial College of Science and Technology. Sir Richard Glazebrook asked for favourable consideration of such research by the Air Ministry.

The position of airship research was shown by the inquiry into the disaster to R38, but, in pursuance of instructions from the Air Ministry, the Aeronautical Research Committee has been unable to carry out its programme. A paper by Commander C. C. Burney on " The Establishment of a Self-Supporting Airship Service " has led to a reopening of the subject and to a divergence of opinion between the Air Ministry and Admiralty which is generally regretted. It appears that the Admiralty needs airships and is prepared to pay for them, but that the Air Ministry considers itself to be the proper body for supervising their construction. While it is hoped that the latter body will prevail, it would appear to require a change of policy and a real desire to retrace its disastrous past. Sir Alan Anderson expressed the point briefly when he asked whether it was really necessary to build airships at considerable cost in order to put them into sheds and let them decay. Probably this action, typical of late policy, had much to do with the objections voiced by representatives at the Air Conference to the predominance of a military policy.

For heavier-than-air craft the feeling of the Conference appeared to be that the tide was turning, notably in the case of fundamental research. Sir Geoffrey Salmond mentioned many specific experiments and a few fundamental inquiries. Those relating to safety and trustworthiness received most attention in the discussion; but one item can be dealt with here. The dangers of flying are few so long as the engine is running perfectly, a state which cannot be relied on to persist for many consecutive hours. Failure of the power plant brings about a forced landing, and where the ground is unsuitable an accident follows. The dangers are increased by a peculiarity of an aeroplane when its wings are inclined to the wind at more than twenty degrees, for it then becomes uncontrollable. During the past year the trained and skilled experimental pilots of the Royal Aircraft Establishment, working in co-operation with a panel of the Aeronautical Research Committee, have modified an aeroplane and flown it at an angle of forty degrees. This is a momentous advance, for it leads to the hope that the danger arising from lack of control may be greatly reduced by further knowledge. It is therefore gratifying to find that the Air Ministry is ready to provide special aeroplanes solely for research by the Aeronautical Research Committee. It will be necessary to develop instruments for the inquiry, for we are still without adequate means of observation in flight except for the simplest types of motion, but again the Air Ministry is ready to give assistance.

Our lead in aeronautical research has been greatly reduced by America, but we appear to be regaining our power for progress, and a continuation of present policy may be expected to lead to that progress in aviation which is so clearly required for projected developments in civil aviation and for the defence of the realm.

Industrial Applications of the Microscope.

A MEETING of the Royal Microscopical Society was held on January 24, for the purpose of inaugurating an important departure in the history and attitude of the society towards national industry by the formation of a special section to deal with the industrial applications of the microscope.

Prof. F. J. Cheshire, president of the society, in his opening address, said that many years ago it had been seriously contended by some pessimistic fellows of the Society that its principal work of usefulness was done. Events of late years, however, had refuted that contention. Why, it was asked, have we a Royal Microscopical Society and not a Royal Telescopical Society? The answer was obvious. In the case of the telescope, practically any tyro could take out an instrument, of which he knew nothing or very little, direct it to the moon or any other object, and could, with a little practice, obtain the very best image which that telescope was capable of giving. The microscope could not be used in that simple way. It was the most complicated of all the optical instruments in common use, and it demanded, in its user, a considerable amount of optical knowledge and manipulative skill before it could be used efficiently and satisfactorily. The use of the microscope as a tool was extending day by day, advancing step by step with the recognition of the great importance of the study of micro-organisms and micro-structures. The Royal Microscopical Society had already carried out certain work in connexion with the industrial applications of the microscope. Sections, dealing with metallurgy, the manufacture of leather and of paper, had been in existence for a short time, but it was recognised that these specific sections made it difficult for the society to deal, as it ought to do, with the practical applications to new industrial work. In these circumstances it had been decided to form a large general section dealing with industrial applications of the microscope. The work of the section would be to encourage, in every possible way, the use of the microscope in industry and, at the same time, to give the most generous assistance to workers in the new fields of endeavour. Any one interested, whether a fellow of the Society or not, would be cordially invited to attend the meetings of the section.

A communication by Dr. F. J. Brislee dealt with the necessity of providing facilities for more definite instruction and training in the practical use and manipulation of the modern microscope, and outlined the manner in which the Royal Microscopical Society could be of assistance to those who had to use the microscope in industrial processes. Dr. Brislee further indicated the lines on which this practical training should proceed, starting with low-power work, the preparation, mounting, and examination of specimens, and proceeding gradually to the more difficult problems.

Dr. J. S. Owens (Superintendent to the Advisory Committee on Atmospheric Pollution) read a communication on atmospheric pollution. The importance of this subject to those working in large factories and to the general health of the community was insisted upon, and many interesting exhibits and lantern slides illustrated the means by which samples of polluted air were collected and examined. The method adopted is one in which a given volume of air is collected and then deprived of suspended matter by causing it to issue from the container as a jet and impinge against a prepared glass surface. Many unsolved problems were submitted to the meeting and suggestions invited as to the best methods of determining the actual nature of the particles of dust, oil, micro-organisms and other foreign matter collected.

In connexion with the leather-making industry, Dr. Browning suggested the more general use of the microscope in the control of the various processes. He showed sections of skin before and after puering, and stated that *if* it was necessary to remove the elastic tissue by puering, then this could be controlled only by the use of the microscope. Samples examined from several sources showed that different manufacturers were content with more or less removal of the elastic tissue. They could not all be right. Every detail in the preparation of specimens and the cutting of sections of leather was practically demonstrated by Miss Scott, and finished slides were exhibited.

Apparatus specially constructed for research work in many industries was demonstrated and described by Messrs. J. W. Atha and Co., R. and J. Beck, Ltd., The Cambridge and Paul Instrument Co., Ltd., Ogilvy and Co., J. Swift and Son, and W. Watson and Sons, Ltd.

Prof. Michelson's Work in Astronomical Interferometry.

MR. POST-WHEELER, who is on the staff of the American Embassy, attended at the annual general meeting of the Royal Astronomical Society on February 9 to receive the gold medal on behalf of Prof. A. A. Michelson, who was unable to be present himself.

Prof. Eddington gave a most illuminating address on the reasons of the award, explaining that the necessity for the great separation of the mirrors receiving the pencils of light from the stars was to give sufficient difference of length of path to enable the rays from the two extremities of a diameter of the star to be in opposite phase, so that the bright regions of the image from one extremity should fall on the dark regions of the other and so cause the fringes to vanish. It was mentioned that the method had been successfully applied to the measurement of the diameters of Jupiter's satellites, but the stars seem to have been considered hopeless, till recent physical work on the distribution of energy in the spectrum led to the conclusion that the red stars have such dull surfaces that the brighter ones must have appreciable discs in order to give so much light.

The actual figure had been calculated for Betelgeuse, and the observed diameter afterwards proved to be very close to it.

Some letters from Mr. Pease were read, in which he described the great practical difficulties that were incurred in applying the method of diffraction fringes, and the long-continued trials that were finally crowned with success. One of the earliest successes was the determination of the orbit of Capella. This gave, for the first time, a really accurate value of the mass and absolute magnitude of a giant star, which had already proved of use in the physical studies that were being made on these bodies.

A recent interesting development of the Betelgeuse measures was that the diameter came out different at different times, to an extent much beyond the probable errors of the measures. Attempts were being made to correlate these changes with the variable brightness and variable radial velocity of the star, but it will be necessary to carry on these measurements for some time before a definite conclusion could be reached.

Prof. Eddington went on to point out that the famous Michelson-Morley experiment, for which the Copley medal of the Royal Society was awarded in 1907, though not specially contemplated in the present award, might be considered as coming within its terms; for the measures were made by interference methods, and the question whether the movement of the earth through the ether could be detected was one of the highest astronomical interest. He knew that their medallist was disappointed at the negative result, but the whole of the system of relativity had been founded upon it, so that in his (Prof. Eddington's) opinion it was more fruitful than a positive result would have been.

In handing the medal to Mr. Post-Wheeler he asked him to transmit to Prof. Michelson their congratulations on his success and their good wishes for the long continuance of his fruitful labours. Mr. Post-Wheeler replied in a few suitable words expressing his sense of the pleasure it gave him to be there as the representative of America, and thanking the Society for the honour they had conferred upon his country in the person of Prof. Michelson.

University and Educational Intelligence.

BIRMINGHAM.—The Mitsui family of Japan has made a gift of 5000*l*. to the faculty of commerce. The Council has decided to apply the gift to the foundation of a chair of finance which, in view of the personal connexion of the Mitsui family with the university and of their generous contribution to its funds, is to be designated the Mitsui professorship of finance.

Mr. F. W. M. Lamb has been appointed assistant lecturer in pathology.

At the annual meeting of the Court of Governors, the principal appealed for more assistance from the districts surrounding the city. These districts at present contribute only 3500*l*. per annum to the university as against 15,000*l*. given by the city, although half the students come from outside the city.

CAMBRIDGE.—Mr. J. B. S. Haldane, New College, Oxford, and Trinity College, has been appointed Sir William Dunn's reader in biochemistry. Mr. A. Hutchinson, Pembroke College, has been appointed University lecturer in crystallography. Dr. C. Shearer, Clare College, has been appointed University lecturer in embryology.

MANCHESTER.—The following lecturers have been appointed: physics, Dr. J. C. M. Brentano; engineering, Mr. H. W. Baker; biological chemistry, Mr. A. D. Ritchie.

OXFORD.—The vice-chancellor has appointed Sir Archibald E. Garrod, Regius professor of medicine and student of Christ Church, to act as deputy for the current term to Dr. Rudolph A. Peters, fellow of Gonville and Caius College, Cambridge, who has recently been elected Whitley professor of biochemistry in succession to the late Prof. Benjamin Moore.

The Weldon memorial prize, which was founded in 1907 by friends of the late Prof. Weldon, to perpetuate his memory and to encourage biometric science, has been awarded to Dr. Johannes Schmidt, director of the Carlsberg Laboratory, Copenhagen. This prize is awarded every three years, without regard to nationality, sex, or membership of any university, to the person who, in the judgment of the electors, has, in the six years next preceding the date of the award, published the most noteworthy contribution to biometric science. Previous recipients of the prize have belonged to St. Andrews, London, and Washington University, St. Louis. On one occasion it was awarded to a lady, Miss Ethel M. Elderton, fellow of University College, London.

SHEFFIELD.—Mr. W. Vickers has been appointed lecturer in education and master of method.

PROF. R. V. WHEELER, professor of fuel technology in the University of Sheffield, has been awarded the Greenwell medal of the North of England Institution of Mining and Mechanical Engineers, for his researches on coal.

THE first of a special series of lectures on "Master Minds and their Work," arranged in connexion with the London County Council's scheme of lectures for teachers, was delivered at King's College on February 14 by Dr. Charles Singer, whose subject was Leonardo da Vinci (1452–1519). The object of the series is to illustrate, by the history of the work and influence of a few great men of various nationalities, the truth that in the study of the history of science is to be found a strong appeal to the spirit of community among men. It is suggested that this line of study will show that all nations have borne their share in building up the structure of knowledge according to the opportunities and civilisation of the times. Succeeding lectures are as follows:—February 21, Descartes (1596–1650), Prof. H. Wildon Carr; February 28, Newton (1642–1727), Prof. A. R. Forsyth; March 7, Pasteur (1822–1895), Sir D'Arcy Power; March 14, Helmholtz (1821–1893), Sir W. M. Bayliss; March 21 (at University College, Gower Street, W.C.1.), Darwin (1809–1882), Prof. Karl Pearson.

The annual prize distribution was held at the Sir John Cass Technical Institute on Wednesday, January 31, and the awards were distributed by Sir Thomas Holland. The chairman of the governing body, the Rev. J. F. Marr, in giving a summary of the work of the Institute during the past session, stated that during this period a total of 1073 students had been in attendance—the highest figure yet attained. The year had not been an easy one, for financial considerations were and still are conspicuously in the foreground. The needs of technical education cannot be satisfactorily met without mutual trust and confidence between the public authorities and those administering the funds placed at their disposal, and without a full belief in the national value of technical education. Despite the restricted accommodation in the science departments, 31 students had been engaged in research work and five papers had been published, bringing the total number of original investigations issued from the Institute to 120. For the second year in succession a student of the metallurgy department had been awarded the first prize (Silver Medal) in the City and Guilds of London Institute examination in non-ferrous metallurgy.

The Attorney-General, Sir Douglas McGarel Hogg, distributed the prizes at the Borough Polytechnic on Friday, February 2. Mr. J. Leonard Spicer, chairman of the governors, referred to the fact that Sir Douglas Hogg's father, Mr. Quintin Hogg, was the founder of the great Polytechnic in Regent Street, and Sir Douglas himself had throughout his life been associated with that Institute. Sir Douglas Hogg, in his address, said with regard to the work of the Institute, that it was not their desire to turn out a number of half-fledged amateurs to compete with the men in the workshops, but by technical instruction to enable those in the workshops to make themselves more efficient and to make greater progress in the industry to which they belonged. The policy of the governors in supplementing the experience of the workshop by trade instruction, and of selecting teachers who themselves had worked in the trades, is undoubtedly sound. The women's side of the Polytechnic is strong, and some of the activities of the Borough Polytechnic are unique in the south-eastern counties of England; the School of Bakery and Confectionery has no parallel, and the Department of Painters' Oils, Colours and Varnishes represents highly specialised and valuable technological departments. The Polytechnic has received valuable assistance from expert trade committees, trades unions, and associations of employers, in order to keep its work closely related to the current needs of industry. Principal Bispham, in his report, stated that both in quality and bulk the work of the past session was a record one and altogether a worthy tribute to the former principal, Mr. C. T. Millis, who has recently retired.

Societies and Academies.

London.

Royal Society, February 8.—**L. Bairstow, Miss B. M. Cave, and Miss E. D. Lang**: The resistance of a cylinder moving in a viscous fluid. The equations of motion of a viscous fluid in the approximate form proposed by Oseen are taken as a basis for calculations of the resistance of a circular cylinder and the surface friction along a plane. In the case of the circular cylinder experimental information obtained at the N.P.L. is wholly suitable for the purposes of comparison with the present calculations. A resistance coefficient is found which is about 30 per cent. greater than that observed at the limit of the range of observation. Calculations for the plane show singularities at the edges, but lead to a resistance which is in rough agreement with experiment.—**G. I. Taylor**: The motion of ellipsoidal particles in a viscous fluid. According to Dr. G. B. Jeffery ellipsoidal particles immersed in a moving viscous fluid assume certain definite orientations in relation to the motion of the fluid. Ellipsoidal particles of aluminium and immersed in water glass take up such positions, but they take a long time to get to those positions. In the meanwhile they oscillate in the way indicated in Dr. Jeffery's analysis.—**W. E. Dalby**: Further researches on the strength of materials. In a new apparatus, an alternating load, push and pull, can be applied to a test piece in such a way that the curves of load and elastic extension are recorded photographically. The yield in tension and compression is found to be substantially the same, and the modulus of elasticity is the same, but alternating load is met by alternating response. When a load of either sign is removed the response is elastic, but imperfectly so. When a load is re-applied, but of opposite sign to the load removed, the response is mainly plastic. By means of a new instrument an alternating torque can be applied to a test piece in such a way that the curves of torque and elastic twist are recorded photographically. This shows that alternating torque is met by an alternating response in shear. It is possible to predict a practical fatigue limit from these diagrams.—**Lewis F. Richardson**: Theory of the measurement of wind by shooting spheres upward. A steel sphere, about the size of a pea or a cherry, is shot upwards from a gun, which is not rifled. The gun is inclined from the vertical towards the advancing air, and the tilt adjusted by trial until the returning sphere falls very close to the gun. The tilt is then some measure of a weighted average of the wind, in the region extending from the ground up to the maximum height attained. This height is found from the time of absence of the sphere. The observation of the tilt and time is repeated for greater and greater heights in succession. Mathematically speaking, the problem involves a "linear integral equation of the first kind," which is solved approximately by transforming it into a moderate number of algebraic simultaneous equations. In the general part of the theory an approximation which fails at the vertex of the trajectory is made. A special and sufficiently correct theory or a correction to the general theory meets this difficulty.—**Ernest Wilson**: On the susceptibility of feebly magnetic bodies as affected by tension. When magnetite is subjected to tensile stress of 50-130 kgrm. per sq. cm. as a maximum, the susceptibility for a given value of the magnetic force at first increases and then decreases as the specific load continuously increases, and exhibits a reversal point as in iron. The magnetic force at which the percentage increase in permeability has a maximum value is less than the magnetic force at which maximum susceptibility occurs.—L. C. **Jackson** and H. Kamerlingh **Onnes**: (1) Investigations on the paramagnetic sulphates at low temperatures; (2) Investigations on the paramagnetism of crystals at low temperatures.—W. D. **Womersley**: The specific heats of air, steam, and carbon dioxide.—D. W. **Dye**: The valve-maintained tuning fork as a precision time standard. The valve-maintained fork is steady in frequency to a degree beyond that required for most purposes. The most serious cause of variation of frequency is that due to temperature. The temperature must be kept constant to 0·1° C. if accuracy to one part in a hundred thousand is required. By the use of a special steel ("elinvar") having a very small temperature coefficient of elasticity, it is probable that the variation of frequency with temperature could be reduced to one-tenth that of ordinary steel forks. The other factors causing variation of frequency are not themselves variable without attention to an extent which would cause a variation of more than a very few parts in a hundred thousand. By suitably choosing the capacities and the anode voltage, a variation of voltage of ±10 per cent. will cause a change of only about one part in a million in frequency.

Geological Society, January 24.—Prof. A. C. Seward, president, in the chair.—S. H. **Haughton**: On reptilian remains from the Karroo beds of East Africa. Three specimens of a small fossil from black shale from the middle of the Karroo formation, near Tanga, on the coast of Tanganyika Territory, represent a new genus and species of aquatic reptile resembling Mesosaurus. It may be regarded as an aquatic adaptation of Youngina. If so, the shale at Tanga is approximately of the same age as the Middle Beaufort beds of South Africa.—Rev. C. **Overy**: Glacial succession in the Thames catchment-basin. A definitive succession-grouping for high-level gravels of the Thames catchment-basin is established. A norm series with effective nomenclature for the Berkshire-Oxfordshire area is suggested, namely, P_{350}, P_{300}, P_{265}, P_{230}, P_{210}, P_{160}, P_{135}. Grading and analysis in the Hampshire and London areas result in the establishment of the norm series for the whole river-system. In this way light is thrown on the age of the Goring Gap, the mode of deposition of the plateau-gravels, glacial succession in the Thames basin, and the bearing of the distribution of drift constituents on the history of the Thames river-system. Evidence is given for the course of the pre-Pleistocene Thames, for the continuity of the Evenlode, Goring Gap, Henley Gorge, Colne-Lea divide, and Essex-coast system.

Physical Society, January 26.—Dr. Alexander Russell in the chair.—C. **Chree**: A supposed relationship between sunspot frequency and the potential gradient of atmospheric electricity. Dr. L. A. Bauer has concluded that both the range of the diurnal inequality of atmospheric electricity potential gradient and the mean value of the element for the year increase and diminish with sunspot frequency. The conclusion was based on observational data from the Ebro Observatory, Tortosa, Spain, between 1910 and 1920. Kew electrical data from two periods of years, the Ebro data utilised by Dr. Bauer, and magnetic data from Kew Observatory were treated mathematically. The results indicate that if a relationship of the kind exists, the sunspot influence must be very much less in the case of atmospheric electricity than in that of terrestrial magnetism.—J. J. **Manley**: A further improvement in the Sprengel pump. The pump was described in Proc. Phys. Soc., vol. 34, p. 86. The present improvement provides a mercury seal during periods when the pump is out of use, whereby the formation of fresh-air skins is prevented.—D. **Owen**: Null methods of measurement of power factor and effective resistance in alternate current circuits by the quadrant electrometer. The methods are extended to high-tension circuits. The usual formula for the quadrant electrometer is applicable only when the needle is maintained at its mechanical and electrical zero.—C. E. **Prince**: An electro-capillary relay for wired wireless. The relay is intended for use with a calling device in connexion with high-frequency currents acting as carrier waves for telephony over power-mains. The high-frequency current is rectified and passed through a thread of mercury which is contained in a capillary tube, and is in contact at each end with some acid containing platinum leads. The passage of the current causes the mercury thread to move. The capillary tube is arranged horizontally on a beam which, as soon as the mercury moves, overbalances in consequence of the weight of the latter and closes the circuit of a call bell or lamp. In series with the thread and with a rectifier is arranged a condenser in which the charge that has passed round the circuit is stored, and after the call this charge is sent through the mercury and acid in the reverse direction; this restores the mercury to its original position. If the call be unanswered the same result is produced more slowly by a high-resistance leak. The instrument responds to currents of 4 or 5 or even 2 microamperes. The total movement appears to be proportional to the coulombs which pass.

Linnean Society, February 1.—Dr. A. Smith Woodward, president, in the chair.—Sir Sidney F. **Harmer**: On Cellularine and other Polyzoa.—Sir Nicholas **Yermoloff**: Notes on Chætoceros and allied genera, living and fossil. Chætoceros is highly differentiated for pelagic life; it occurs in the planktons of the colder seas, sometimes, especially in spring, in colossal numbers. Some 100 living species have been described, but only 6 or 7 are common in the planktons. The parent cells, each consisting of two valves with a hoop between them, form colonies, holding together by means of long setæ; they have thus great floating capacity. Several species develop internal organs, covered with a thick siliceous wall, called statospores, inside the mother-cells. Their function is not known. The mother-cells, or colonies, as such, never appear in any fossil marine deposits, though the spores appear fairly often. The spores of Chætoceros have been taken in the past as separate Diatom genera, and classified and named as such. Fossil spores of Chætoceros are frequent in Miocene diatomaceous earths. The most common form is Syndendrium Ehr., the spore of *Chætoceros diadema* Gran, which is very common in the planktons.—H. L. **Clark**: Some echinoderms from West Australia.

CAMBRIDGE.

Philosophical Society, January 22.—Mr. C. T. Heycock, president, in the chair.—Sir Joseph **Larmor**: (1) The stellate appendages of telescopic and entoptic diffraction. (2) Can gravitation really be absorbed into the frame of space and time? (*see* NATURE, February 10, p. 200).—H. F. **Baker**: The representation of a cubic surface upon a quadric surface.—H. Hartridge and F. J. W. **Roughton**: Measurements of the rate of oxidation and reduction of hæmoglobin. Methods were devised for estimating instantaneously the percentage saturation of hæmoglobin with oxygen, for mixing instantaneously either reduced hæmoglobin with an oxidising agent or oxyhæmoglobin with a reducing agent, and for preparing rapidly the reduced hæmoglobin solution in large quantities. Oxidation takes place exceedingly rapidly, in approximately one-hundredth part of a second at 10° C., whereas reduction takes approximately one second. The rate of reduction agrees with the formula deduced on the assumption that the reaction is mono molecular, and the ratio of the rates of the two reactions was of the same order as the value of the equilibrium constant. In the body both changes take place at temperatures considerably higher than those used. They would be expected therefore to be even faster (some ten or twenty times) in the body than in these experiments. —J. T. **Saunders**: A method of measuring the carbon dioxide output of aquatic animals. The method is based on the fact that, from measurements of the hydrogen ion concentration of solutions of bicarbonates of known concentration in equilibrium with carbon dioxide, the tension, and so the amount dissolved, of carbon dioxide can be calculated.—Miss D. **Eyden**: Changes in the specific gravity of *Daphnia pulex* L. *Daphnia pulex* increases in specific gravity immediately after feeding and diminishes after starvation. These changes may account for the vertical movements of forms living in the plankton.

DUBLIN.

Royal Irish Academy, January 22.—Prof. Sydney Young, president, in the chair.—A. K. **Macbeth**: The action of sulphur chloride on ammonia and on organic bases. The action of sulphur chloride on ammonia was examined quantitatively. No sulphur nitride hitherto unknown was isolated, but a new derivative containing sulphur, nitrogen, and hydrogen was described. This compound, which it is proposed to call hexasulphamide, appears to have the composition S_6NH_2. The action of sulphur chloride on the aromatic amines was examined qualitatively, and the course of the reaction at low temperatures was studied with *o*-toluidine, N-dithiotoluidine being isolated.—T. P. C. **Kirkpatrick**: Charles Willoughby, fellow of the King and Queen's College of Physicians. In 1690 Dr. Charles Willoughby wrote a paper dealing with the political economy and vital statistics of Ireland which he sent to William King, then Bishop of Derry. It was published in full in the Proceedings of the Royal Irish Academy in 1857. Recently a letter from King has come to light in which he gives information about the condition of the people in the country, and the difficulties in collecting statistical information. Some letters from Willoughby to King throw an interesting light on medical practice in Dublin at the end of the seventeenth century. While studying medicine in Padua, where he graduated M.D. in March 1663/4, Willoughby made a collection of botanical specimens, which he afterwards presented to Merton College. Willoughby was one of the founders, and was the first director of the Dublin Philosophical Society, and in 1675 he was elected president of the College of Physicians. He died in 1694.

PARIS.

Academy of Sciences, January 22.—M. Albin Haller.—G. **Bigourdan**: The co-ordinates of the Observatories of Muette and Passy.—L. **Lecornu**: The orbit of Mercury. A development of a suggestion of M. Haag in a recent note, showing that the displacement of the perihelion of Mercury can be explained by adding to the Newtonian attraction a small tangential force and a small force directed towards the sun.—L. **Maquenne**: Remarks on a recent communication of MM. P. A. Dangeard and Pierre Dangeard. A discussion of some consequences of the observation that leaves of *Aucuba japonica* suffer no loss of vitality over a period of several months if preserved in a vacuum and exposed to light.—E. **Leclainche** and H. **Vallée**: Vaccination against symptomatic anthrax by toxins. A discussion of the difficulties and limitations attending vaccination by toxins derived from *B. Chauvoei*.—A. **Blondel**: The determination as a function of the initial conditions of the free oscillations of alternators working in parallel and connected individually with motors with theoretical regulation, instantaneous and fixed. Application to synchronous motors.—A. **de Gramont**: Observations on the structure of the chromium spectrum. Directing attention to the recent experimental confirmation by M. Catalan of the theoretical views propounded by the author in November 1922.—C. **Guichard**: Polar figures reciprocal with respect to a sphere.—A. **Guntz** and **Benoit**: The heat of oxidation of the metals of the alkaline earths. A repetition of earlier work with purer material. The heats of oxidation of calcium, strontium, and barium were found to be 152·7, 141·8, and 134·04 calories respectively.—A. **Bigot** and Mme. E. **Jérémine**: New observations on the geology of the Hague (Manche). M. Philippe Glangeaud was elected corresponding member for the section of mineralogy in the place of the late Otto Lehmann.—Erwand **Kogbetliantz**: The double means of Cesàro.—S. **Stoïlow**: Continued functions and their derivatives. —C. **Kuratowki**: The effective existence of functions representable analytically every Baire class.—M. **Alliaume**: The nomographic resolution of systems of equations.—H. C. **Levinson**: The Einstein gravitation of systems.—Emile **Picard**: Remarks on the preceding communication.—G. **Poivilliers**: A method of stereoscopic representation of topographical surfaces.—Paul **Dienes**: The relativist electromagnetic theory.—G. **Gire**: The dissociation of potassium chloro-iridate.—Pierre **Steiner**: The ultraviolet absorption spectra of the alkaloids of the isoquinoline group. Narcotine, hydrastine, and hydrocotarnine. The ultraviolet absorption spectrum of narcotine is determined by the benzene ring of its molecule; the isoquinoline nucleus only displaces the absorption towards the red end. For papaverine, on the contrary, it is the isoquinoline and not the benzene ring which is the determining factor.—A. **Catalan**: The structure of the arc spectra of molybdenum, selenium, and chromium.—F. W. **Klingstedt**: The ultraviolet spectra of aniline and the toluidines. The results are given in diagram form, and differ considerably from the data obtained by earlier workers in the same field. —Mlle. **Chamié**: The ionisation produced by the hydration of quinine sulphate. A direct connexion between ionisation and the amount of water taken up is proved.—A. **Bouzat**: A class of unstable hydrates known as hydrates of gases. Confirmation of M. Villard's hypothesis. Many gases form hydrates possessing the following properties: their formula is $M \cdot 6H_2O$, they are unstable, formed with a small heat evolution starting with the constituents in the solid state, and on dissociation lose all the six molecules of water at once.—L. **Franchet**: A new industrial material of the neolithic age. An account of the discovery of neolithic agricultural implements made of polished sandstone, at Piscop.—Pierre **Lesage**: The persistence of the characters produced in plants by salt.—Antonin **Němec** and Kvapil **Karel**: The biochemical study of forest soils.—V. **Crémieu**: The growth of plants and the principles of physics.—L. M. **Betancès**: The ageing of the hæmatic cell.—G. **Ramon**: Dissociation of the diphtheria toxin-antitoxin complex and the recuperation of the antitoxin.—F. **Heim**, E. **Agasse-Lafont**, and A. **Feil**: The rôles of lead and turpentine in the professional pathology of painters. From a comparative study of painters divided into two groups, one using paints containing lead and the other working with lead-free paints, the authors conclude definitely that it is not turpentine but lead and its compounds which are the cause of renal lesions and hypertension in painters.

Official Publications Received.

Abstract-Bulletin of the Nela Research Laboratory, National Lamp Works of General Electric Company, Cleveland, Ohio. Vol. 1, No. 3, October. Pp. ix+303-521. (Cleveland.)

Summary of the Annual Report of the Naval Observatory for the Fiscal Year 1921. (Appendix No. 2 to the Annual Report of the Chief of the Bureau of Navigation.) Pp. 53. (Washington: Government Printing Office.)

Nauka Polska: jej Potrzeby, Organizacja i Rozwój. (Polish Science: its Needs, Organisation and Progress.) III. (Year-Book of the Mianowskie Institution for the Promotion of Scientific Research Work.) Pp. vi+280. (Warszawa.) 150 marks.

Report of the Department of Mines for the Fiscal Year ending March 31, 1922. (Sessional Paper No. 15.) Pp. iii+48. (Ottawa.) 5 cents.

Department of the Interior: United States Geological Survey. Mineral Resources of the United States in 1921 (Preliminary Summary). Pp. iv+102A. (Washington: Government Printing Office.)

Crichton Royal Institution, Dumfries. Eighty-third Annual Report, for the Year 1922. Pp. 49. (Dumfries.)

National Museum of Wales. Fifteenth Annual Report (1921-22) presented by the Council to the Court of Governors at a Meeting held in Cardiff on the 27th October 1922. Pp. 35+6 plates. (Cardiff.)

Diary of Societies.

SATURDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (1).

MONDAY, FEBRUARY 19.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Dr. R. L. Sherlock: The Influence of Man as an Agent in Geographical Change.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. P. Sexton and others: Discussion on Esprit de Corps.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. V. Lanchester: Architecture and Architects in India.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—C. E. M. Joad: The Problem of Freewill in the Light of Recent Developments in Philosophy.

FARADAY SOCIETY (at Chemical Society), at 8.—Prof. A. W. Porter and J. J. Hedges: The Law of Distribution of Particles in Colloidal Suspensions with Special Reference to Perrin's Investigations, Part II.—D. B. McLeod: A Relation between the Viscosity of a Liquid and its Coefficient of Expansion; The Viscosity of Liquid Mixtures showing Maxima; A Relation between Surface Tension and Density.—M. Cook: Crystal Growth in Cadmium.—F. H. Jeffery: Electrolysis with an Aluminium Anode, the Anolyte being (1) Solutions of Sodium Nitrite, (2) Solutions of Potassium Oxalite.—S. D. Muzaffer: Electric Potential of Antimony-Lead Alloys.

ROYAL SOCIETY OF ARTS, at 8.—Dr. H. P. Stevens: The Vulcanisation of Rubber (Cantor Lectures) (3).

TUESDAY, FEBRUARY 20.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—J. Hilton: Statistics of Unemployment derived from the Working of the Unemployment Insurance Acts.

INSTITUTE OF TRANSPORT (at Institution of Electrical Engineers), at 5.30.—F. Bushrod and J. F. S. Tyler: Modernisation of Passenger Railway Stations.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions to the Society's Menagerie during the Month of January 1923.—Prof. H. M. Lefroy: Exhibition of Cinematograph Films of the House-fly.—Dr. N. S. Lucas: Reports on the Deaths which have occurred in the Society's Gardens during 1922.—Prof. E. Lönnberg: Remarks on some Palaearctic Bears.—E. W. Shann: The Embryonic Development of the Porbeagle-Shark, *Lamna cornubica*.—R. Gurney: Some Notes on *Leander longirostris*, M.-Edwards, and other British Prawns.

INSTITUTION OF CIVIL ENGINEERS, at 6.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—A. S. Newman: The Causes of Static Trouble in the Kinematograph, and Means for its Elimination.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—W. J. Jones, E. A. Marx, Jr., and others: Discussion on the Projection of Light.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—P. E. Newberry: The Beb Sed Festival of Ancient Egypt.

SOCIOLOGICAL SOCIETY (at Royal Society), at 8.15.—Prof. J. A. Thomson: Biological Contributions to Sociology.

WEDNESDAY, FEBRUARY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. C. Pearson: Greek Civilisation and To-day (2), Progress in the Arts.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—R. L. Braithwaite: The Flow of Lymph from the Ileo-Cæcal Angle and its possible bearing on (1) the formation of Gastric and Duodenal Ulcer, and (2) the cause of other types of Indigestion.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—Informal Meeting.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Col. E. Gold and others: Discussion on Reform of the Calendar, by C. F. Marvin.—Dr. S. Fujiwhara: The Growth and Decay of Vortical Systems.—Dr. S. Fujiwhara: The Mechanism of Extratropical Cyclones (Third memoir on Vortical Phenomena).

ROYAL SOCIETY OF ARTS, at 8.—C. Ainsworth Mitchell: Handwriting and its Value as Evidence.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Sir William Maddock Bayliss: Microscopical Staining and Colloids.—A. Mallock: Note on the Resolving Power and Definition of Optical Instruments.

THURSDAY, FEBRUARY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. B. Melvill Jones: Recent Experiments in Aerial Surveying (2).

ROYAL SOCIETY, at 4.30.—G. I. Taylor and C. F. Elam: The Distortion of an Aluminium Crystal during a Tensile Test (Bakerian Lecture).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. W. G. Savage: Canned Foods in Relation to Health (Milroy Lectures) (1).

INSTITUTION OF STRUCTURAL ENGINEERS, at 7.30.—E. Godfrey: Shear Resistance.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Principal J. C. Irvine: Some Constitutional Problems of Carbo-hydrate Chemistry.

CAMERA CLUB, at 8.15.—E. R. Ashton: Picturesque India.

FRIDAY, FEBRUARY 23.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Theatre, Imperial College of Science and Technology), at 2.30.—Sir John Russell, H. G. Thornton, and others: Discussion on Partial Sterilisation of Soil: Present Views as to its Effects and their Causes.

PHYSICAL SOCIETY OF LONDON, AND RÖNTGEN SOCIETY (at Imperial College of Science and Technology), at 3.—Demonstrations: Major C. E. S. Phillips: A Method of Measuring X-ray Intensity.—E. J. Evans: Intermittent Discharge from Sectorless Wimshurst Machine.—L. H. Clark: An X-ray Balance.—H. B. Gough: Ionometer.—W. E. Schall: Spectrometer for Measuring End-radiation.—Dr. F. L. Hopwood: The Ondoscope.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 5.—Dr. L. Hogben: Intersexuality and Sex Reversal.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—E. R. Flint: Abnormalities of the Hepatic and Cystic Arteries and Bile Ducts.

PHYSICAL SOCIETY OF LONDON, AND RÖNTGEN SOCIETY (at Imperial College of Science and Technology), at 5.—Discussion on The Measurement of X-rays.—Sir William H. Bragg: Introductory Address.—Prof. S. Russ: The Measurement of X-ray Intensity and the Necessity for an International Method.—F. T. Harlow and E. J. Evans: The Quality of X-rays produced by Various Types of High-tension Generators and an Incandescent X ray Bulb.—Dr. M. Berry: Practical Measurements for Medical Purposes.—Dr. G. W. C. Kaye and Dr. E. A. Owen: X-ray Protective Materials.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. J. Tracey: Characteristics, Operation, and Maintenance of Underground Cables.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. S. Eddington: The Interior of a Star.

SATURDAY, FEBRUARY 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (2).

BRITISH PSYCHOLOGICAL SOCIETY (at Bedford College), at 3.—Prof. T. H. Pear: An Examination of some Current Beliefs concerning Muscular Skill.—Miss M. MacFarlane: The Use of Mental Tests in American Schools and Clinics.

PUBLIC LECTURES.

SATURDAY, FEBRUARY 17.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. F. A. Bather: A Limestone Cliff and the Animals that built it.

MONDAY, FEBRUARY 19.

KING'S COLLEGE, at 5.30.—Dr. W. Brown: Psychology and Psychotherapy (1). (Succeeding Lectures on February 26 and March 5.)

TUESDAY, FEBRUARY 20.

LONDON SCHOOL OF ECONOMICS, at 5.—S. P. Vivian: Statistics, before, during, and after the War: Population.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. T. G. Bailey: The Sansis, or Thieves of India; their Language, History, and Customs.

KING'S COLLEGE, at 5.15.—Dr. J. H. Orton: The Bionomics of Marine Animals (1). (Succeeding Lectures on February 22 and February 23).—At 5.30.—Prof. H. Wildon Carr: Physical Causality and Modern Science (1). (Succeeding Lectures on February 27, March 6, 13, 20, and 27).—Prof. A. J. Toynbee: The Expansion of Europe Overland (1). (Succeeding Lectures on February 27, March 6, 13, 20, and 27.)

WEDNESDAY, FEBRUARY 21.

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.15.—Prof. Miles Walker: The Control of the Speed and Power Factor of Induction Motors (1). (Succeeding Lectures on February 26, March 14 and 21.)

KING'S COLLEGE, at 5.30.—Prof. F. Soddy: A Physico-Chemical Theory of the Instability of Western Civilisation.

SATURDAY, FEBRUARY 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30—S. H. Warren: The Interplay of Land and Sea.

NATURE

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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Intellectual Regimentation.

SIR MICHAEL SADLER has done a good service, "one stroke of faithful work," by envisaging again the question whether teachers should be Civil Servants. The title of this article is one of many happy phrases in his brilliant, if not altogether conclusive, address at the annual meeting of the Assistant Masters' Association. Our present measure of freedom from State control in education, he said, was the possibility of resisting, if the need arose, "intellectual regimentation." Against this important but contingent attribute of intellectual freedom, the primrose path of State control of education appears to lead to rare and refreshing fruit for teachers. One of the *sequelæ* of the Burnham salary scale with its regular increments has been that senior assistant masters and mistresses in secondary schools run considerable risk of being displaced by younger teachers entitled to lower salaries under the scale. It is stated indeed that teachers have been dismissed in this way purely on grounds of economy. In any event, there must be a tendency under existing conditions for the teaching profession to become immobile.

State control of education would offer to teachers security of tenure, fair if not generous salaries and pensions, an impartial system of promotion and transfer. It would secure greater uniformity in the work and organisation of our schools, a higher standard of scholarship and training in the teaching profession, and a stricter discipline. These results have been attained more or less completely in France and Germany, where the influence of the State on education is more "decisive and peremptory" than in Great Britain. English-speaking countries have usually preferred to leave the appointment of teachers in the hands of local boards, corporate bodies, or individual employers.

But with the Labour Party definitely committed to a policy of nationalisation on a large scale, the question of State control of education in Great Britain cannot be regarded as purely academic. Sir Michael Sadler, while expressing his personal preference for our present system, thought the trend during the last five years had been in the direction of State control. Mr. Fisher's Superannuation Act for teachers, for example, was closely modelled on the Civil Service pension system. Further, the finance of public education has in recent years become so chaotic that the magic wand of bureaucratic control may be invoked to produce some sort of order. We must not forget that, two generations ago, under somewhat similar conditions as regards the standard and efficiency of elementary education, Mr. Robert Lowe introduced the system of "payment by results"; a system which its author commended on the ground that the nation would be assured of value for its money. In the present distressing condition of the national finances, the president of the Board of Education may be searching for some empirical solution of our educational troubles which he could commend for the same reason.

If the straight issue be joined between intellectual freedom and bureaucratic control, we have no doubt that in the present temper of the public and of the teaching profession, the decision would be emphatically against bureaucratic control. In the recent educational conferences, the point of view of the teachers on this question was expressed without reservation or ambiguity. The fact is the war has produced a marked mistrust of "regimentation" in any form, mistrust of both its methods and its results. English people, in accord with their history and traditions, will show great caution in adopting any form of organisation which may tend to thwart the free growth and play of personality and the full exercise of political freedom. By ensuring the ninety-nine parts of education which is diligent and orderly routine, we must not stifle the hundredth part, which is art.

This, however, is not to say that the problem of the relation of the State to education does not exist. On the contrary, the question of State control is encountered not only in education but also in other professions such as medicine and the promotion of scientific research, and, more urgently perhaps, in the extensive field of industry. Any advance in dealing with the question in one aspect must affect others and orientate the national mind towards a general solution. We plead, therefore, that the best creative thought of our teachers, men of science, and statesmen should be dedicated to the question of defining the true function of the State in various departments of our national life.

Without attempting to explore the question in all its implications, we would suggest that if in any particular case State control or nationalisation is found to be the best solution of existing difficulties or the best policy for the future, its form should be adapted to special conditions. In teaching and scientific research particularly, spiritual values must be conserved, mechanical methods avoided, and the workers themselves as the real experts must be assured a fair share of direction and control. Some amount of "intellectual regimentation" may be necessary in the fight against ignorance and vice and in attacking complicated scientific problems. But from neither the teacher nor the scientific worker will the best results be obtained if their direction and control come from an authority which they may regard as external, ignorant, unsympathetic, and autocratic. In submitting these observations, we are in no sense attacking the policy of the Labour Party or any other political party. An eminent politician has suggested that we are all socialists nowadays. This is true in the sense that our work is directed in an increasing measure to the good of the community. The question of State control is one of method and machinery rather than of ideal, and should be studied in a cold scientific light, without personal or political prejudices or vituperation.

Formalism and Mysticism.

Tractatus Logico-Philosophicus. By Ludwig Wittgenstein. (International Library of Psychology, Philosophy and Scientific Method.) Pp. 189. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1922.) 10*s*. 6*d*. net.

READERS of Mr. Bertrand Russell's philosophical works know that one of his pupils before the outbreak of the war, an Austrian, Mr. Ludwig Wittgenstein, caused him to change his views in some important particulars. Curiosity can now be satisfied. The "Tractatus Logico-Philosophicus" which Mr. Ogden has included in his new library of philosophy is a remarkable and strikingly original work. It is published in German and English in parallel pages. It is difficult to appreciate the reason for this, seeing that the author is evidently familiar with our language and has himself carefully revised the proofs of the translation. Also we should have liked to have the Tractatus without Mr. Russell's Introduction, not, we hasten to add, on account of any fault or shortcoming in that introduction, which is highly appreciative and in part a defence of himself, in part explanatory of the author, but for the reason that good wine needs no bush and that Mr. Russell's bush has the unfortunate effect of dulling the palate instead of whetting the appetite. In his penultimate sentence Mr. Russell says: "To have constructed a theory of logic which is not at any point obviously wrong is to have achieved a work of extraordinary difficulty and importance." We agree, but how uninspiring when compared with Mr. Wittgenstein's own statement of aim: "What can be said at all can be said clearly, and whereof one cannot speak, thereof one must be silent."

In fact, when we come to the root of the matter there seems to be little in common between pupil and teacher. When we read Mr. Russell's works we feel indeed that what we can know of the universe is little enough in comparison with what we can never know, but yet he recognises no limit to the logical classification of its constituent entities. Indeed he seems to aim at an exhaustive inventory, at least of classes. Mr. Wittgenstein, on the other hand, makes us feel with Spinoza that our knowledge is limited to two modes of the existence of a being who himself exists in infinite modes.

The Tractatus consists of seven main propositions, six of which admit of expansion and aim at saying clearly what can be said. The seventh admits no expansion. It affirms the limit of what is expressible, the inexpressible, and it acquiesces in silence. In its form, the Tractatus recalls the Monadology of Leibniz; in its content, it approximates, as we have indicated, to Spinoza. Logic is the ladder by which we rise to a vantage-point from which we survey reality, but when we have risen we recognise that the logical propositions which have supported us are in themselves meaningless: we must throw them away in order to see the world rightly, and then, face to face with reality, we find it is inexpressible.

The six main propositions are the rungs in the ladder. (1) The world is everything that is the case. (2) What is the case, the fact, is the existence of atomic facts. (3) The logical picture of the facts is the thought. (4) The thought is the significant proposition. (5) Propositions are truth-functions of elementary propositions (an elementary proposition being a truth-function of itself). (6) The general form of truth-function is (omitting the symbols and substituting the interpretation) that every proposition is the result of successive applications of the operation of negating all the propositions making up any set of propositions, to the elementary propositions. The seeming obscurity of this last sentence may perhaps be removed by a quotation. "The propositions of logic demonstrate the logical properties of propositions, by combining them into propositions which say nothing. In a logical proposition propositions are brought into equilibrium with one another, and the state of the equilibrium then shows how these propositions must be logically constructed."

These six main propositions are not elaborated in the deductive or analytic manner, but it is shown that a number of propositions depend upon them in a way which proves that logic is a constructive process. It will be seen, then, that the Tractatus is not a book to be read cursorily; every proposition will only be understood if the reader succeeds in himself thinking the thought of it. Its appearance is a notable event in the philosophical world and will be received in many quarters as a challenge.

Probably the central point of interest is the meaning which Mr. Wittgenstein attaches to what he calls the atomic fact. Outwardly it appears to agree with what Mr. Russell describes generally as logical atomism, but when we get down to the atomic fact itself, it becomes as different from Mr. Russell's description of the constituent element as the modern scientific conception of the atom is different from the Democritean. For Mr. Wittgenstein the atomic fact is a system. "In the atomic fact objects hang one in another like the members of a chain." Further on he tells us we must not say, "the complex sign *aRb* says *a* stands in relation *R* to *b*"; what we must say is "*that a* stands in a certain relation to *b* says *that aRb*." If we accept this, what is left of the famous theory of relations? Also to Mr. Wittgenstein those well-known nonsense propositions which play so large a rôle in the Russellian logic are nonsense, that is, they are not propositions, they are nothing.

The interest of the Tractatus will doubtless culminate for most students in the mysticism with which it concludes. Pure formalism in logic must mean mysticism in philosophy. "Logic is not a theory but a reflexion of the world." It is transcendent. Logic is language. It is the clear expression of all that is expressible. But when we have said all that is sayable there remains unexpressed, inexpressible, the will, the life, the *that* we live as distinct from the *how* we live. "Of the will we cannot speak." "If good or bad willing changes the world, it can only change the limits of the world, not the facts." Philosophy when it follows the right method and says nothing but what can be said, says nothing which concerns philosophy. Such is the conclusion of this remarkable, thought-provoking book.

There is one serious omission of the editors which at times is embarrassing to the student. Writers are referred to whose special theories the reader is presumed to know, but there are no references to guide him should he wish to consult the originals.

H. WILDON CARR.

Outlines of Astronomy.

General Astronomy. By H. Spencer Jones. Pp. viii + 392 + 24 plates. (London: E. Arnold and Co., 1922.) 21*s*. net.

TO deal in any adequate sense and in an elementary manner with the whole subject of astronomy requires both inclinations and aptitudes which are not altogether common. It is a field in which the greatest success may fairly be claimed for English and American writers. Thus in France, in spite of a genius for scientific romance which serves admirably in an allied and more restricted domain, the pen of Arago has found no conspicuous successor. Similarly in Germany the continued success of "Newcomb-Engelmann" is not merely a tribute to the original American masterpiece, but also betrays a native inability to create a serious rival. In one case we may suspect a natural impatience in tracing detail over a vast region, in the other a lack of that discriminating power which is needed in order to keep the detail in its due subordinate place. A nice sense of proportion and construction is as necessary as a sufficient technical equipment, and modern specialism is scarcely conducive to the combination of these qualities.

In his preface Mr. Jones alludes to the twin difficulties of inclusion and omission. But an author need not be obsessed by such problems in drawing the outlines of a science for the benefit of the uninstructed. His is the right to choose his own material. A critic may insist on orderly arrangement, coherence, and critical accuracy. He may go further and point out that what purports to be a complete picture falls far short of the intended aim, that essential features are lacking. But the author will do well to anticipate these two lines of criticism in a different spirit. The first is universal, and applies to all books as works of art or science. The second is truly pertinent, and yet may be disregarded by the author. For he must draw the picture as he himself sees it, and not as he imagines others will expect it to be drawn. Let it be incomplete or exaggerated, if that cannot be helped, but let it represent a personal view. In this way there is at least more to be gained than would otherwise be lost. It is only thus that a really fresh and graphic delineation becomes possible, and that is not altogether easy in a field where the predecessors have been many and some of them distinguished. Mr. Jones has successfully maintained his independence, and the result will be recognised as conveying a consistent, complete, and just representation of modern astronomy within the assigned limits of space and technical reasoning. A very simple algebraic or trigonometric formula is introduced occasionally, but the arguments, though generally effective, are elementary, and involve little or no formal mathematics. The book is written in a clear and simple style, and the illustrations have been chosen with judicious care.

The last three decades have witnessed a wonderful transformation in astronomy. To the undiscerning eye the progress of the science during the nineteenth century may well have appeared dull. It was then that the foundations were being laid for future advance, and this on two distinct lines. Steady adherence to established methods was laboriously accumulating the material on which notable generalisations and a more critical view of the whole subject could be founded, and at the same time more enterprising spirits were making trial of new methods which, owing to difficulties of technique, were not always immediately productive. It has so happened that the triumph over these difficulties, with the provision of new and powerful instrumental resources, has coincided with the critical discussion for which the stores of existing observations were ripe. The result of this confluence is that a text-book of general astronomy written in the nineteenth century, however excellent at the date of its appearance, could scarcely be brought up to date by any process short of re-writing the whole of it more or less completely.

It is, however, obvious that the foundations of astronomy have been so well and truly laid that the earlier chapters must follow a long familiar track. The landmarks are old, but even here there is some liberty of choice, and Mr. Jones's choice appears both fresh and judicious. A clear preliminary chapter on the celestial sphere shows that the author intends to be serious and not merely popular. It is not evident why the definitions of the ecliptic and celestial longitude and latitude are deferred to a later chapter. The two chapters which treat of the earth are excellent, the topics being well chosen and discussed at such length as to make them really instructive. The statement (p. 42) that twilight is least at the equinoxes is incorrect; in this country shortest twilight falls some three weeks nearer the winter solstice. In the chapter on the moon, which follows, a clear statement of the principal features of the lunar motion is very welcome.

The treatment of the sun naturally introduces the results of more modern work. It is curious that the word photosphere does not seem to occur, and the subtle problem connected therewith is entirely ignored. The subject of eclipses is explained very lucidly in a separate chapter. Here it may be noted that the index is capable of improvement. Thus the Einstein test by the deviation of stars in the field of the sun is described (p. 155), but omitted from the index, and the same thing happens with Janssen's and Lockyer's discovery (p. 130), that it was possible to observe prominences without an eclipse.

As one would expect from the author, the chapter on astronomical instruments is excellent, dealing with the more important modern types in a lucid manner. Astronomical observations are also explained briefly but clearly. A very attractive account of the planets and their systems is preceded by a simple explanation of the main features of planetary motion, and followed by a descriptive treatment of comets and meteors.

The concluding section of the book consists of three chapters dealing with the stars and the stellar system in the light of modern research. Possibly a fuller discussion of the whole of this fascinating subject would have been welcome, but restraint is necessary in a branch where research is progressing at a particularly rapid rate, and within the limits of space assigned it is difficult to see how a better choice of subject-matter could have been made. The subject of photometry receives that attention to which its importance entitles it. On the other hand, radial motions are passed over with little mention. The confusion of Betelgeuse (p. 285) with α Bootis is curious, and other slips will be noticed. The spectroscopic determination of the parallax of α Centauri (p. 330) is due to W. H. Wright (not to Campbell). An argument occurring in the section on short-period variables is quite unsound; it would be just as reasonable to assert that the earth-moon system cannot be binary on similar grounds. But in such matters allowance ought to be made for the need for brevity. The subject of these three final chapters might easily be expanded into a large volume.

It cannot be denied that the book is marred by a number of minor errors. They may be attributed to the want of the author's revision, owing to the recent eclipse expedition of which he was in charge. In passing a book through the press the most zealous and competent editor can scarcely replace the author himself. Certain corrections are called for in the interest of accuracy and for the instruction of the serious student, and will be easily introduced in a later edition. In the meantime, the general reader should find in the present work an interesting review of the methods and principal features of modern astronomy, from which he can gain an insight into its spirit and general trend. H. C. P.

A Text-book of Metallography.

An Introduction to the Study of Metallography and Macrography. By Dr. L. Guillet and A. Portevin. Translated by L. Taverner. With an Introduction by Prof. H. C. H. Carpenter. Pp. xvi + 289 + Plates cxvii. (London: G. Bell and Sons, Ltd., 1922.) 30*s.* net.

THE handsome volume before us is the largest general text-book of metallography that has yet appeared in English, and the preface states that the authors have in preparation a still larger treatise, which is evidently intended to deal with the subject very fully. Their presentation is essentially French, and is worthy of the school founded by Osmond and Le Chatelier. In any historical account of the origins of metallography the name of Sorby is necessarily mentioned, but neither the authors nor Prof. Carpenter, who writes an introduction, quite do justice to his remarkable work. Sorby not only devised the method of preparing and examining micro-sections of metals, but he also described correctly and identified the principal constituents of several varieties of iron and steel, and recorded their structures in photographs which leave nothing to be desired in clearness and accuracy. These photographs appeared in 1887, or seven years before the classical paper of Osmond, in which the study was advanced many stages further. Sorby's experiments were actually made, at least with the lower powers, in 1864, but the lack of interest taken in them by manufacturers led him to put them aside until the work of Martens again directed attention to the use of the microscope in the study of metals.

The characteristic feature of this volume by Messrs. Guillet and Portevin is its wealth of illustrations, mostly excellent. The least satisfactory are those showing the process of recrystallisation in cold-worked metals, for which better material is now available. Taken as a whole, however, the plates reach a very high standard. The equilibrium diagram and other theoretical sections are treated briefly but clearly, and more stress is laid on practical applications than is usual in text-books. The physical properties of alloys are only cursorily reviewed, and the experimental determination of changes of volume might well have been described, in view of the fact that dilatometric results are used freely in the account of the special steels. The chapter on mechanical testing describes French machines, and needs to be supplemented for English readers. No fatigue test is included, and the list of etching reagents (awkwardly called "etchants") is rather meagre, and might well be enlarged. The concrete studies of groups of technical alloys are very useful, and bring together a large amount of information, but the section on alloy steels is out-of-date; it is based on the older papers of Guillet, and the important group of light alloys receives little attention.

The most novel feature of the work is the section devoted to macrography. This is actually older in date than microscopical metallography, having been employed by Widmanstätten in 1808 in the study of meteorites. It is not so well known as it should be that Sorby employed "nature-printing" to record the structure of converted bars in 1864, printing from an etched surface by means of printers' ink. This method was extensively used in this country during the war for examining shell and other forgings. The authors do not describe nature-printing, but give a good account of the etching of metallic surfaces for macro-photography, and of the interpretation of the results so obtained. This section is of great value.

The translation is clear and smooth. Proper names have suffered rather badly (Bénédick for Benedicks, Marten for Martens, Brani for Bruni, Carnilley for Carnelley, etc.) but other misprints do not appear to be numerous. As a comprehensive survey of a subject of growing importance, the book is likely to have a wide popularity. C. H. D.

Our Bookshelf.

Gas Manufacture, Distribution and Use: Teachers' Notes for Lessons, with Blackboard Illustrations. Second and revised edition. Pp. 148. (London: Compiled and Published by the British Commercial Gas Association, 30 Grosvenor Gardens, 1922.)

As may be gathered from the title, the primary purpose of this volume is to place at the disposal of teachers who wish to give lessons on the subject trustworthy information which may be of service to them. In addition, the introduction of a number of simple and clear diagrams is intended to lighten the task of illustrating lessons on the blackboard. The book will serve its purpose admirably. The information is of the right kind, and in the hands of a good teacher, who will naturally select what he wants for his own purpose, should be capable of rendering excellent service.

It would be a mistake, however, to suppose that the usefulness of the book would be confined to those who wish to use it for teaching purposes. As a matter of fact it brings together, and presents systematically, descriptions of gas plants, gas appliances of all kinds, and illustrations of their use such as it would be impossible to consult, so far as we know, in any single work. There is probably nobody in the gas industry, or preparing for it, who would not find this book useful at times, and for the journalist who in the absence of more thrilling themes may be called upon to deal with "the gas peril" it should provide a very desirable substratum of corrective knowledge.

Moreover, the householder who wishes to have a better understanding of the construction and method of operation of the gas appliances which he has installed, or is thinking of installing, will almost always be able to find something pertinent to the questions before him in one or other of the 121 lessons here set out, while in Appendix C, under the head "Gas by the Therm," he will find a clear explanation of this unit of heat as a basis of charge with a summary of the circumstances leading up to the Gas Regulation Act of 1920.

J. W. C.

The Failure of Metals under Internal and Prolonged Stress: a General Discussion held on Wednesday, April 6, 1921, in the Hall of the Institution of Mechanical Engineers. Edited by F. S. Spiers. Pp. iv+215. (London: Faraday Society, 1921.) 10*s*. 6*d*. net.

THE general discussion on the failure of metals, organised by the Faraday Society in conjunction with a number of technical institutions, was one of the most successful of the series. The volume containing the papers and discussions is likely to serve for some time to come as the standard source of information on season-cracking and similar defects in worked metals. The phenomenon is a puzzling one, and it was necessary first of all to collect the observations of many workers, whose experience touched the subject at different points, before any attempt at explanation could be made. The metallurgist and engineer, however wide his experience, will probably find much in the volume that is new to him. The very extensive records from Woolwich Arsenal are particularly valuable.

The theory of the origin of season-cracking is still imperfect. The hypothetical amorphous film between the crystal grains of metals is invoked by Dr. Rosenhain and others as the responsible material, but other workers have found the evidence unconvincing, and it is too early to say that any satisfactory explanation of the whole of the facts has been devised. Hardening cracks in steel present a rather different problem, but one so closely related to that of season-cracking as to justify their inclusion in the same volume. Fortunately, the results of recent work are not of academic interest merely, but experiments have shown that the cracking of cold-worked objects may be prevented entirely by annealing at a temperature so low as to cause no appreciable loss of hardness. This result has great theoretical as well as practical importance.

C. H. D.

Die europäischen Bienen (Apidæ). Das Leben und Wirken unserer Blumenwespen. Bearbeitet von Prof. Dr. H. Friese. 1 Lieferung. Pp. 112+7 Tafeln. (Berlin und Leipzig: W. de Gruyter und Co., 1922.) 10*s*.

THE name of Dr. H. Friese is well known to students of the Hymenoptera, and his published writings on bees render him competent for a work of this description. His aim is to give a general account of the life and habits of European bees within a compass of about 450 pages, of which 112 pp. are comprised in this first instalment. In some ways the work is scarcely abreast of the times, and it is a matter of surprise to find in the introduction the old Linnean classification of insects still adhered to, with the dragonflies included among the Orthoptera. Bees are regarded as constituting a single family, and the other major groups of Hymenoptera are relegated to a similar status. Furthermore, no outline of the classification of the Apidæ is presented to the reader, which is a distinct drawback. The section devoted to the general characters of bees might well have been longer—it is too brief and elementary to be of much value to the serious student. We note only the barest reference to the salivary glands, respiration system and other organs, although several pages are devoted to an account of the body-hairs, nearly fifty different kinds being illustrated. The author's main aim, however, is bionomics, and it is evident that the remainder of the book, when completed, will provide a trustworthy, well-illustrated dissertation on the habits and life-economy of the insects with which it deals. The seven coloured plates which accompany the present part are composed of original figures. Those which portray the various types of nest structure are among the most attractive illustrations of their kind which we have seen.

A. D. IMMS.

Morbid Fears and Compulsions: their Psychology and Psychoanalytic Treatment. By Dr. H. W. Frink. Reprinted from the American Edition. Pp. xxiv+344. (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1921.) 21*s*. net.

DR. FRINK's text-book deals with psycho-analytical treatment and the theories on which it is based. In the introduction, by the late Dr. James Putnam, there is a criticism of Freud's view that the duty of the psychotherapist ends with the undeception of the patient and the dissipation of his symptoms, without any consideration of the use he will make of his newly acquired freedom.

The first four chapters are devoted to a presentation of the theories underlying psycho-analysis, based on purely Freudian doctrines, but abundantly illustrated by the author's own observations and cases. After a description of sexual development, the unconscious and the censorship, the neuroses are considered in detail—the method of their production, their classification and individual psychology. A long description is given of a case of compulsion neurosis and its analysis, which is of considerable value in illustrating the preceding chapters on theory.

The book is evidently intended for, and will appeal most to, the student who has some acquaintance with psycho-analysis, and is desirous of extending his knowledge on the subject.

Reinforced Concrete Simply Explained. By Dr. Faber. (Oxford Technical Publications.) Pp. 77. (London: H. Frowde and Hodder and Stoughton, 1922.) 5*s*. net.

A very clear and simple account of the elementary principles of reinforced concrete design is given in Dr. Faber's book, and it will be found suitable for those who wish to have the knowledge required for the design of simple structures which will be safe, but not necessarily the last word in economy. The book covers the ground required for beams, slabs, and pillars. Both shearing and bending are considered in connexion with beams, and the effects of fixing the ends and of continuity are clearly explained. The design of pillars also includes a simple treatment of the bending moments communicated to the pillar by beams which are integral with it. There are very few blemishes, and these are of a minor character only, *e.g.* on p. 33, Fig. 7, the lower arrow for the dimension *d* is misplaced. On the whole the book is the soundest production of an elementary character which we have yet seen, and will be very useful to students of engineering who have to acquire a knowledge of reinforced concrete among other subjects in their course.

Memoirs of the Geological Survey: England and Wales. The Geology of the London District. (Being the Area included in the Four Sheets of the Special Map of London.) By H. B. Woodward. Second edition, revised, by C. E. N. Bromehead; with Notes on the Palæontology by C. P. Chatwin. Pp. vi+99. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1922.) 1*s*. 6*d*. net.

This new edition of the brief general geological guide to the London District, issued at a moderate price, will be of interest to thousands of citizens who spend their daylight leisure in rambles beyond London's fringe. The nature of the ground below the city is well brought out; but the four sheets of the one-inch map covered by the memoir also include pleasant fields where the outcrops of the strata may be traced. The description of the gravels shows how much may be learned from material excavated in the urban areas, when this is correlated with the terraced deposits of the Thames valley as a whole. The description and classification of stone implements is brought well up-to-date. G. A. J. C.

Lecture Demonstrations in Physical Chemistry. By Dr. S. van Klooster. Pp. vi+196. (Easton, Pa.: The Chemical Publishing Co.; London: Williams and Norgate, 1919.)

Dr. van Klooster has brought together a number of experiments suitable for lecture demonstrations in physical chemistry. These experiments, to the number of 253, include, in addition to the more obvious experiments such as the determination of molecular weights, a series of thirty experiments on colloids and adsorption, some eighteen experiments on actino-chemistry, and conclude with a short series of experiments in which liquid air is used. When physical chemistry is taught to advanced students, lecture demonstrations are often regarded as superfluous; but with the growing importance of the subject the demand for suitable illustrations is likely to increase. The volume before us will, therefore, be welcomed by many teachers who will find it a considerable help in introducing experimental demonstrations into their lecture courses.

Manual of British Botany: Containing the Flowering Plants and Ferns arranged according to the Natural Orders. By C. C. Babington. Tenth edition, with amended Nomenclature and an Appendix. Edited by A. J. Wilmott. Pp. lvi+612. (London: Gurney and Jackson, 1922.) 16*s*. net.

In this edition Mr. Wilmott has endeavoured to bring the names up-to-date; and on the vexed question of nomenclature has, so far as possible, cited the author who first gave to the name employed the connotation expressed in these pages. In the appendix have been inserted the more important revisions of genera (*e.g.* Moyle Rogers "Conspectus of the Rubi"), additional species, and, in places, important information connected with the main body of the work; the inclusion of all varieties now accepted—many of which were deliberately rejected by Babington—having proved impossible. For its size and weight (7½ oz.) the manual might be deemed expensive; but it has a value possessed by no other for the serious student of the British flora.

Le Mouvement scientifique contemporain en France. No. 1. Les Sciences naturelles. By Dr. G. Matisse. (Collection Payot. No. 10.) Pp. 160. (Paris: Payot et Cie., 1921.) 4 francs.

Those desirous of keeping touch with the recent work of French biologists, but unable to consult the original memoirs, will find here useful epitomes of the results and views of some of the more prominent workers. The first chapter is devoted to Lacaze-Duthiers and the Roscoff laboratory. The subsequent chapters contain summaries (i.) of the work of Yves Delage and Bataillon on heredity, artificial fertilisation, etc.; (ii.) of Houssay's experiments in dynamic morphology, in which those dealing with the shapes of fish are of especial interest; (iii.) of the results achieved by Cuénot, Bohn, and Réné Quinton in their several fields of research; and on the botanical side (iv.) of Chauveaud's work on plant development and transitory tissues; Molliard's investigations of the structural effects of artificial nutrients, and of parasitism; and Matruchot's cultivation of basidiomycete fungi from the spore to maturity.

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.*]

On the New Element Hafnium.

THROUGH the courtesy of the editor of NATURE we have been able to see an advance proof of the letter of MM. Urbain and Dauvillier (NATURE, February 17, p. 218), and are glad to have the opportunity to add the following comment:

Our main reasons for believing that the element celtium, the detection of which was announced by Urbain in 1911, is altogether different from the element detected by us and named hafnium, are:

1. Celtium and hafnium show very great differences in their chemical properties. While we have found no difficulty in purifying hafnium preparations from contents of rare earths, the separation of celtium from the rare earths was found by Urbain to be so difficult, that although the detection was announced in 1911, only samples of small concentration have been obtained up to the present time.

2. It has not been possible by means of highly concentrated hafnium preparations to reproduce the characteristic optical spectrum ascribed by Urbain to celtium, and which, together with an investigation of the magnetic properties of his preparation, was the basis of the announcement of the discovery of this element. The result of a closer investigation of the optical spectrum of hafnium will soon be published.

3. The X-ray spectrum of a preparation containing a percentage of an element high enough to measure magnetic properties should show the characteristic X-ray lines of this element in great intensity, altogether different from the exceedingly faint lines found by Dauvillier. Quite apart from the possibility of accounting for these lines as due to a higher order spectrum of other elements, it seems to be very unlikely that these lines should be due to a contamination of Urbain's preparation by a trace of hafnium. Not only as stated in our first letter (NATURE, January 20, p. 79) they do not coincide within the limit of experimental error with our measurements of the wave-lengths of the hafnium X-ray lines L_{a_1} and L_{β_2}, but also the reason given by Dauvillier for not detecting the line L_{β_1}, which is stronger than L_{β_2}, can scarcely be maintained. In fact, our measurements for this line give a value which differs about 3 X-units from the Lu-line denoted by Dauvillier as L_{β_2}', and with the dispersion used it should be easily separated from the latter line.

As stated in our letter in NATURE of February 10, p. 182, hafnium appears in large abundance in zirconium minerals, and we estimate the hafnium content of the earth's crust to be more than one part in 100,000. In the meantime we had the highly interesting information from Prof. V. Goldschmidt in Christiania, that in an investigation of zirconium minerals, in collaboration with Dr. Thomassen, he has discovered a mineral in which hafnium is a main metallic constituent. This has been verified by an X-ray investigation in this Institute of a sample kindly sent to us by Prof. Goldschmidt. On the other hand, an investigation of certain preparations extracted from a titanium mineral from New Zealand and kindly sent to us by Dr. Scott did not reveal any hafnium line. Taking the sensitiveness of the method into account, this mineral cannot contain appreciable amounts of hafnium.

The question discussed by MM. Urbain and Dauvillier which elements are to be ascribed in the family of rare earths, has hitherto been a matter of pure definition. The recent development of the theory of atomic structure, however, has given the question involved an entirely new aspect. The appearance of a group of elements in the 6th period in the periodic table exhibiting very similar chemical properties but quite different magnetic ones could be explained by Bohr on the basis of the fundamental principles of the quantum theory (for particulars cf. Bohr's Nobel lecture, shortly to appear in NATURE). For this atomic theory the properties of the elements in the 6th period of the periodic table have therefore become of great importance. The stimulus to our present investigations was provided by the great difficulty of reconciling this theory with the results announced six months ago by Dauvillier and Urbain. In fact, the existence of an element with atomic number 72 and the chemical properties ascribed to celtium cannot be reconciled with the theory. Our confidence in the theory, however, has been amply justified. For by following up the theoretical deductions we have been led to detect a new element, which is the proper analogue of zirconium and with atomic number 72, present in considerable abundance in the earth's crust. This confirmation of the theory was the deciding factor in our choice of the name hafnium for the new element.

D. COSTER.
G. HEVESY.

Copenhagen, February 9.

Hafnium and Titanium.

THE black iron sand from New Zealand examined by Dr. Scott in 1915 in which, as he informed the Chemical Society at its meeting on February 1, he found a substance which he is now inclined to regard as probably identical with an oxide of the new element recently discovered by Dr. Coster and Prof. Hevesy of Copenhagen, and named by them hafnium, was doubtless similar in character to the deposit observed to occur in the bed of a rivulet at Tregonwell Mill, near Menaccan, in the parish of St. Keverne, Cornwall, and also in a stream at Lenarth, in the same parish, and in which the Rev. William Gregor, the minister of that parish, who analysed the deposit in 1789, first detected the existence of the element now known as titanium.

The Cornish mineral, a titaniferous iron sand of variable composition, was known mineralogically as menaccanite, and the new element was consequently termed menachin. Similar deposits occur in other parts of the world, and, in fact, are widely distributed. Their characteristic constituents are known variously as ilmenite, iserine, thuenite, hystatite, washingtonite, crichtonite, etc.; the results of analyses of them by Mosander, Marignac and Kobell are to be found in Greg and Lettsom's "Mineralogy," and a list of localities in which they occur is given by Dana. Their composition is very variable, the amount of titanic acid, for example, ranging from 22·2 per cent. to 46·9 per cent. They are all essentially iron titanates, associated with variable amounts of oxides of iron, and, occasionally, of manganese and other substances.

The name titanium was given to the element by Klaproth as the result of his detection of it in rutile and ilmenite, and in ignorance, apparently, of Gregor's prior discovery, although this was announced in Crell's *Annalen* of 1791. Klaproth's experiments were confirmed by Vauquelin and Hecht in 1796. Klaproth subsequently examined menaccanite, and found that menachin and titanium were identical.

The atomic weight of titanium was made the subject of investigation by Rose in 1823, and again in 1829; by Mosander in 1830; by Dumas in the same year; by Pierre in 1847, and by Demoly in 1849. The methods employed were not identical, but they usually depended upon the analysis of the tetrachloride, which was held to be sufficiently purified by fractional distillation. The results were extremely discrepant, far more so than could be explained by ordinary analytical errors. The values for the atomic weight of titanium ranged from 47 to 56. The determinations have been discussed by Becker, and, independently, by Clarke in the "Smithsonian Collections," and also by Meyer and Seubert. Clarke contents himself with remarking that the atomic weight of titanium is "imperfectly determined," and Meyer and Seubert place titanium in the list of those elements of which the value is uncertain to within several units.

Pierre's determinations made on the tetrachloride were long regarded as the most trustworthy, and his final value 50·25 was adopted in all atomic weight tables prior to 1885.

The position of titanium in the table drawn up by Mendeléeff, in accordance with the requirements of the Periodic Law, was discussed by him on the occasion of the publication of his famous memoir, when he pointed out that the "law" indicated that its accepted atomic weight, based mainly upon Pierre's work, was at least two units too high (see his "Principles of Chemistry," vol. ii. p. 26). A redetermination made upon the carefully purified tetrachloride and tetrabromide proved that Mendeléeff's prevision was correct (Thorpe, *Journ. Chem. Soc.*, 1885, 47, 108), and the value 48·1, then ascertained, was accepted by the International Committee, and finds its place in all recent atomic weight tables.

That there was an undiscovered element associated with titanium in its various naturally occurring compounds has long been surmised. It is almost impossible to escape the conviction that the extraordinarily discordant values for the atomic weight of titanium obtained by the several chemists above referred to are in all probability to be explained by the presence of an element of higher atomic weight in the material investigated by them. Mendeléeff, in the course of conversation with me, more than once expressed his conviction that a diligent search among naturally occurring titaniferous compounds, or among minerals belonging to the same group of elements as titanium, would be rewarded by the discovery of such an element.

T. E. THORPE.

Whinfield, Salcombe, South Devon.

Insulin.

SIR WILLIAM BAYLISS's article in NATURE of February 10, p. 188, displays an attitude of friendly criticism towards the Medical Research Council's policy, in expressing their willingness to accept assignment of the insulin patent from the University of Toronto. The fact that an observer so sympathetic, and having so many opportunities of ascertaining the true nature of the position, should give expression to doubt and disquiet, may well arouse misgiving in a wider circle. There are several points concerning which he is clearly under a misapprehension.

(1) Sir William Bayliss, in stating that "there is a strong feeling here"—*i.e.* in this country—"against patenting products of value in the cure of disease," makes an assumption which seems scarcely justified by the facts. I think his statement is wider than his intention. It can hardly be maintained that such feeling is general, in face of the fact that practically every new remedy obtained by synthesis in the chemical laboratory is not only patented, but exploited for the profit of the discoverer or his employers. Sir William Bayliss is probably thinking only of remedies discovered in physiological or pathological laboratories, the patenting of which has, indeed, been discouraged by the facts that such remedies are usually invented by qualified members of the medical profession, with a wholly honourable tradition against secrecy and monopoly, and that their protection by sound patents is, in any case, difficult. It is, however, not logical that we should look askance at one chemist, who patents a process for extracting a hormone, even if he does it for personal gain, and regard with approval another, who makes a large fortune by patenting the synthesis of, say, a new hypnotic.

(2) It is, however, not necessary, in the instance under discussion, to consider the propriety of patenting remedies for gain. Sir William Bayliss's introduction, in this connexion, of the question of rewards for medical discoverers is really quite irrelevant. Whether the University of Toronto expects to make profit out of the patent is a question for its authorities to answer. I am quite certain, however, that, if profit is made, it will not go to the remuneration of the discoverers, but to make good the heavy expenditure in which the insulin investigation has involved the University, and to make provision for further research upon it. The Medical Research Council, I am confident, will make no profit at all from their action in accepting assignment, not even to replace the money they are spending to make this remedy available and to promote investigation of its properties.

(3) The question of profit being excluded, it is obvious that the Council's action could have no other aim than to assist the public in obtaining the remedy under the best possible conditions, and to prevent the dangers and difficulties which might arise if the preparation were left at the mercy of unrestricted commercial exploitation. Sir William Bayliss sees an easy way to secure these ends. "Would not," he asks, "the best way to effect these objects be to announce that the Medical Research Council were prepared to test and certify preparations sent to them?" He sees himself that this might involve "a large amount of work," and suggests large batches and the delegation of testing to firms having facilities. He may be assured that these possibilities have not been ignored; but it must also be said that he does not begin to see the real difficulties. It will suffice to mention one, which is easily overlooked from the arm-chair of the study, or even from the stool of the academic laboratory. The supply of raw material is not unlimited; it is by no means certain that it will prove adequate to the need of sufferers in this country, even if all of it is properly used. The ordinary methods of commerce would involve a vigorous competition for the material, with no guarantee against the purchase of a large part of it, or even the whole, at artificially exalted prices, by firms concerned only to take advantage of the popular excitement, by selling, at high prices, something which could be represented as "Insulin."

Does Sir William Bayliss seriously suppose that such a situation could be met by a friendly offer to test anything calling itself "Insulin," prepared by any one regarding himself as competent, or wishing to have his share in exploiting a public clamour? Given that the enterprise can be confined to firms possessing the necessary equipment of plant and scientific staff, and that they will agree not to raise the price of the raw material artificially by competition, or of the finished product by combination, there is everything to be said in favour of encouraging them to carry out experiments and improve the process. It is possible also to hand on, to firms accepting such conditions, all information, from any source, which can accelerate production and improve the product. This is, and always has been, the policy of the Medical Research Council. But such a policy has only been made possible, in the existing state of the law, by the Toronto application for patent and the Council's consent to accept assignment.

(4) The most surprising, and the most serious, misunderstanding of the position is revealed by Sir William Bayliss's statement, that "the necessity for any laboratory being unable to do this," *i.e.* to carry out research on insulin—"except by arrangement with the patentees does not seem desirable." I agree that it is not desirable; but the alleged inability is quite imaginary. No such permission is required, but many have sought and have been given help, and many more have received help without seeking. Sir William Bayliss will be familiar with the custom current among scientific workers, of maintaining a certain reticence with regard to work which is unfinished or results which are still in doubt, and even of asking others to keep clear of a certain problem for a time, to avoid duplication. I can state with confidence that, even in that restricted and legitimate sense, there has been no attempt on the part of the Council, or of those working for them, to keep any kind of secrecy or monopoly in this field, so far as pure research is concerned, uncomplicated by questions of personal gain.

In my own department, the whole of our knowledge of this subject has been put freely at the disposal of other pure research workers—not only what has come to us in connexion with the patent, but what has resulted from our own investigations. Sir William Bayliss acquits the Council of "any desire whatever to obstruct such research." I think he might safely allow himself to go a little further, and recognise that their policy in this matter, and its interpretation by those working for them, has resulted in a quite unusual freedom of assistance to research, with both information and material.

H. H. DALE.

The National Institute for Medical Research, Hampstead, February 12.

Multiple Resonance.

SIR RICHARD PAGET'S skilfully demonstrated lecture at University College on October 18, 1922, the substance of which is given in NATURE of January 6, is not less interesting as giving a very simple account of the nature and formation of speech sounds, than as showing how far-reaching and diverse are the applications of "multiple resonance" in acoustics.

Boys (NATURE, vol. 42, p. 604, 1890) made use of a special kind of double resonator in constructing a very sensitive form of "Rayleigh disc," and Rayleigh extended his theoretical consideration of double resonators given in his "Theory of Sound," vol. ii. p. 190, to show that "the condensation in the second resonator may be made to exceed to any extent that in the first, by making the second resonator small enough" (Rayleigh, *Phil. Mag.* xxxvi. 231-4, 1918).

Following some preliminary experiments by Prof. Callendar and Major Tucker in 1918, Capt. E. T. Paris employed the double resonator for the purpose of increasing the sensitivity of the hot-wire microphone originally devised by Major Tucker and also of extending the range (in pitch) of maximum sensitivity.

For a single resonator the response curve is a sharp peak, but with a proper design of double resonator the two peaks (characteristic of such resonators in general) may coalesce, so to speak, into what is practically one broad flat-topped peak. In the accompanying diagram (Fig. 1) the dotted line gives a typical response curve for a single resonator, and the full line is typical of the curve obtained when a resonator of suitable proportions is added, to form a double resonator.

Paris has shown how the form of the resonance curve can be varied with tuning of the component resonators, from equal response to each of the two natural tones, to the case of much stronger response to one than the other. The double resonator of Boys appears to have been of the latter kind. "A doubly-resonated microphone of the type described may be

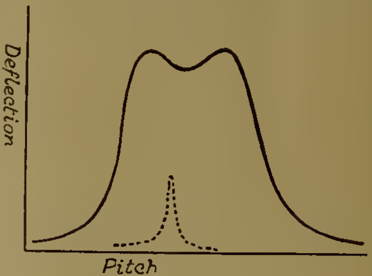

FIG. 1.

more than a hundred times as sensitive (to one of its resonant tones) as a suitably tuned singly resonated microphone with an aperture similar to that of the inner resonator" (E. T. Paris, Proc. Roy. Soc. A, vol. 101, 1922).

The present writer, independently, developed a form of *multiple* resonator to provide a recording system for the Gramophone Co., Ltd., Hayes, Middlesex, having a uniform response over a very wide range—namely four octaves. For so wide a range (129 to 2069 vibs./sec.) the source of sound was a series of stopped diapason, wooden organ pipes, giving fairly pure tones of uniform intensity as judged by the trained ear. The amplitude of vibration of the diaphragm—or of the point of the wax-cutting needle—was observed by means of exceedingly small mirror attachments, the best of which was similar to D. C. Miller's "phonodeik" (Miller, "Science of Musical Sounds," Macmillan). It was possible so to adjust the ten to twenty components of the multiple resonator that the response curve (plotted amplitudes against pitch) would conform very closely to a curve such as that determined by the theoretical constant intensity relation, $a^2 n^2 =$constant, without a serious loss of sensitivity.

A resonator of simple form with yielding walls is a double resonator. Rayleigh, on the suggestion of Clerk Maxwell, considered the case of a sphere with non-rigid walls (Phil. Trans., 1871, p. 87) and showed that it has two natural periods, being a system of two degrees of freedom, like an ordinary double resonator. Similarly, a rigid resonator of conical form with a diaphragm mounted at the narrow end is a double resonator, and so we get an explanation of the fact that the octave interval between the first and second partials for the conical resonator alone, is increased by as much as a tone if the natural frequency of an attached diaphragm falls between the frequencies of the partials.

Multiple resonance will perhaps account for the remarkable evenness of response and the characteristic quality of tone given by the resonating body of good violins. Helmholtz ("Sensations of Tone," 1885 edition, p. 87, Ellis translation) found two tones of greatest resonance on a violin by Bausch, one between 264 and 280, and the other between 440 and 466 vibs./sec., when he tested it by placing the ear against the back of the violin and playing a scale on the pianoforte. Ellis (*loc. cit.* footnote) gives details of elaborate tests made by sounding tuning-forks over the ʃ holes of a number of the best and oldest violins. There were at least two maxima in all cases, but the best specimens gave almost equal response to his forks from 240 to 560, and in the case of Dr. Huggins's Stradivari of 1708, described as one of the best Stradivari, "every fork was more or less reinforced; there was a subordinate maximum at 252; a better at 260-268 vib.; very slight maxima at 312, 348, 384, 412, 420, 428 (the last of which was the best, but was only a fair reinforcement), 472-480, but 520 was decidedly the best and 540 good. No one fork was reinforced to the extent it would have been on a resonator properly tuned to it, but no one note was deteriorated."

The peculiar shape of the body of a violin is such as to give double resonance even if the walls were rigid. Taking into account the vibrations of the wooden walls as well, we have a multiple resonator which will no doubt give an even response over a wide range in the best violin.

Just as Sir Richard Paget's double resonator modifies an artificial larynx to give vowel sounds, so the multiple resonator—the violin body—determines the valued quality of tone of the violin.

Multiple resonance gives promise of being a very fruitful field of research in acoustics.

P. ROTHWELL.

Signals Experimental Establishment,
Woolwich Common, S.E.18,
January 15.

Destruction of the Polarisation of Resonance Radiation by weak Magnetic Fields.

THE earlier studies of the resonance radiation of mercury vapour in exhausted quartz tubes by one of the present writers showed no traces of polarisation, even when the exciting light was polarised.

Recent experiments by Lord Rayleigh apparently indicated that polarisation existed in that part of the excited column at some little distance from the window at which the beam entered; in other words, when the excitation was produced by light from which the core of the 2536 line had been removed by absorption. This observation was not verified in experiments made by one of us last spring and published in a recent number of the *Philosophical Magazine*. The polarisation was found to be strong and of uniform percentage right up to the window at which the beam entered.

On commencing a further study of the phenomenon we found it impossible to produce as strong polarisation as was indicated by the earlier experiments, and after varying the conditions in every conceivable manner we finally found that the disturbing factor was the magnetic field of the earth, the polarisation rising to a very high value (90 per cent.) when the magnetic field of the earth was compensated by a large solenoid carrying a feeble current. In the absence of the solenoid the percentage of polarisation dropped to fifty or less.

This appears to be a new magneto-optic effect, and is manifested only when the magnetic field is parallel to the magnetic vector of the exciting light and perpendicular to the beam of exciting rays. A field of only five or six times the strength of the earth's field practically destroys the polarisation. Discrepancies found previous to the discovery of this effect were due to the fact that in some cases the apparatus faced north and south, and in others east and west. Lord Rayleigh's observation was doubtless due to the stray field of the electro-magnet which was used to flatten the discharge against the wall of his quartz lamp.

R. W. WOOD,
ALEXANDER ELLET.

Baltimore, Jan. 25.

Volcanic Activity in Iceland and Long Distance Transport of "Dust."

WITH reference to the communication on this subject made by Prof. Grenville Cole to NATURE, November 11, 1922 (vol. 110, p. 635), the following additional remarks may be of interest.

In the *Deutsche Fischerei Zeitung* for November 14, 1922, occurs a note which may be summarised as follows: A Geestemunde steam trawler, the *Tyr*, while returning from her last trip to Iceland, experienced a fall of ashy material on her deck. This occurred while at a distance of at least 400 sea miles from Iceland. It is stated that the material was doubtless from Hecla, and though no date of the occurrence is given, it is known that the vessel made Geestemunde on October 25. A communication from the British Consul at Thorshavn also deals with this matter, and reads as follows:

". . . beg to inform you that on October 6 this sandstorm was observed on these islands. The weather was fine that day, but clouded, and the sky had a red-grey colour, and I remember the feeling of getting fine sand in my eyes while being in a rowing boat that morning, and going home to lunch my wife showed me some fine dark grey sand lying in the windows, which had been open that morning.

"I may add that a telegram received from Iceland that day gave the news of volcanic eruption in Iceland."

For these two reports I am indebted to Mr. G. T. Atkinson, district inspector of fisheries, Eastern Area.

J. N. CARRUTHERS.

Ministry of Agriculture and Fisheries,
Fisheries Laboratory,
Lowestoft.

The Wegener Hypothesis and the Origin of the Oceans.

READERS of NATURE have been served with good reviews and discussions on the Wegener hypothesis, and it may therefore be of interest to point out that, so far as it relates to the origin of the Atlantic Ocean, this hypothesis was anticipated by previous writers, more especially by Osmond Fisher and W. H. Pickering. Fisher's views are well known to students of geodynamics, and Wegener himself refers to papers by W. H. Pickering and F. B. Taylor; but only by reading the accounts given by these authors can one realise how completely they forestalled Wegener, so far as the origin of the Atlantic by the westerly drift of the Americas is concerned.

It was to accommodate Sir George Darwin's views on the origin of the moon that Osmond Fisher suggested, first in NATURE (1882, vol. 25, p. 243) and afterwards in the second edition of his "Physics of the Earth's Crust," that the Pacific Ocean is a scar and depression on the earth's surface, left by the detachment of the moon. The following are Fisher's words (p. 380): "The hole would be filled up by the influx of the molten substratum from beneath and around. The remaining crust would separate into larger and smaller fragments, and partly float towards the cavity. Thus when the newly exposed surface of the molten substratum again solidified, a fresh crust, of greater density than before, would be formed out of the heavy substratum over the middle of the area, where the hollow had been made, and also in the channels between the fragments which had floated towards it; the Atlantic being the chief of these channels."

In his paper on "The Place of Origin of the Moon—The Volcanic Problem" (*Journ. Geol.*, 1907, vol. 15, p. 23) W. H. Pickering elaborates the view previously propounded by Osmond Fisher; and although he makes no acknowledgment, we may safely infer that, directly or indirectly, he owed the idea to Fisher. The following quotation shows how remarkably close Pickering got to the statement of the Wegener hypothesis: "A curious feature of the Atlantic Ocean is that the two sides have in places a strong similarity. . . . When the moon separated from the earth, three-fourths of the crust was carried away, and it is suggested that the remainder was torn in two to form the eastern and western continents. These floated on the liquid surface like two large ice-floes."

In his paper on the "Bearing of the Tertiary Mountain Belt on the Origin of the Earth's Plan" (Bull. Geol. Soc. America, 1910, vol. 21, p. 179) F. B. Taylor remarks: "Thus we may conclude, at least provisionally, that it was North America that moved away from Greenland, and not *vice versa*."

If the view that the American continent has drifted away from Europe and Africa during Mesozoic and Tertiary times comes to be established, which seems highly improbable, it will no doubt owe much to Wegener, and will be associated with his name in this special sense; but Osmond Fisher is clearly the author of the hypothesis of continental drift, so far as it applies to the problem of the origin of the Atlantic Ocean. The tectonic evidence provided by a study of the Atlantic floor, however, indicates that its submergence in large part during Tertiary times has been effected by the ordinary process of subsidence, and that, *pari passu* with this subsidence, considerable areas of Eurasia and Africa, which were previously submerged, have been raised above sea-level. Indeed, as Suess has pointed out, the evidence seems to show quite conclusively that, throughout the Mesozoic and Tertiary eras, a mediterranean ocean of the Atlantic type has in a large way dissected the continental masses and absorbed their drainage, although its orientation has changed.

These broad geotectonic considerations seem to be utterly at variance with the claim based by Wegener on the jig-saw relationship of the opposite sides of the Atlantic; and there can be little doubt that, to a large extent, they dispose also of the Fisher hypothesis of continental drift, so far as the origin of the Atlantic is concerned.

It should be remembered, however, that Fisher's views on continental drift were based on the hypothesis he entertained as to the condition of the earth's interior. There are profound differences between the Atlantic and Pacific Oceans. Astronomers tell us that the Fisher hypothesis as regards the Pacific is a very good one, and to this may be added the claim that, in large measure, it fits the facts known to us concerning the petrology and tectonics of the earth. While, therefore, declining to accept Fisher's hypothesis of continental drift to explain the origin of the Atlantic, we may accept provisionally his view that the Pacific owes its origin to the detachment of the moon, especially as some hypothesis seems to be necessary to explain the heterogeneity of the earth's crust.

T. CROOK.

Aster tripolium on Salt Marshes.

I NOTICE in the article on Belgian botany in NATURE of January 20, p. 97, a statement which reminds me of some observations of mine at Dovercourt, near Harwich, in 1908. The article says that a fringe of the purple-rayed form of *Aster tripolium* occurs between the salt marshes, occupied by the yellow form, and the more fertile, less saline, soil. At Dovercourt there are fields overflowed by the sea at every high tide, but still showing signs of former cultivation. The specimens of Aster growing here were all fleshy and rayless. Separated from these fields by earthen dykes were other fields, which showed no signs of being flooded at any time. Here the Aster was always thin and wiry in the stalk, and bore a well-developed ray.

H. W. CHAPMAN.

Cawthorne, Jordans Village,
Beaconsfield, Bucks,
January 31.

The Cause of Anticyclones.

WITH reference to Miss Catherine O. Stevens' letter (NATURE, February 3, p. 150) on this subject, it is clear that there could be no high-pressure areas unless there were low-pressure areas as well.

It is also quite clear that the pressure distribution at any moment depends upon the flow of the winds, the inertia of the air, and the rotation of the earth. But the atmosphere is a viscous substance, and the friction resulting from its viscosity would soon bring the whole mass to rest were there no continuous source of power to keep it moving.

It is generally agreed that the source of power which maintains the circulation of the atmosphere is difference of air density resulting from difference of temperature. The problems to be solved are—what is the exact distribution of temperature throughout the atmosphere? will the actual temperature distribution account for the winds? and how are these temperature differences maintained?

R. M. DEELEY.

Tintagel, Kew Gardens Road, Kew, Surrey,
February 2.

The High Temperature of the Upper Atmosphere.

IN a letter in NATURE of February 10 Mr. Whipple suggests that a comparatively sudden increase in temperature of the air at a height of about 60 kilometres, such as observations of meteors render likely, would account for the well-known zones of audibility and silence. This seems to us a promising line of investigation, which might enable one to determine annual variations of temperature, if any. We had already examined the possibility of using meteor observations for this purpose, but they are as yet scarcely sufficiently accurate to enable one to determine the small differences involved. The same applies to the suggestion of Mr. Deeley in NATURE of January 20.

In the last paragraph of his letter Mr. Whipple suggests that the estimates which we made of the temperature on theoretical grounds require modification, as the atmosphere is exposed to the sun only during the day-time. We need scarcely point out that this fact had not escaped our attention and was allowed for in the coefficients of the formula actually used.

F. A. LINDEMANN.
GORDON M. B. DOBSON.

Clarendon Laboratory, Oxford,
February 12.

The Bicentenary of Sir Christopher Wren.

By Eng.-Capt. Edgar C. Smith, O.B.E., R.N.

Though during the celebration, next week, of the bicentenary of Sir Christopher Wren the main interest must needs centre around his great work as an architect, his position as one of the representative men of science of the seventeenth century should not be overlooked. Five years younger than Boyle, and ten years the senior of Newton, Wren had as his contemporaries Wilkins, Hooke, Goddard, Willis, Sydenham, Flamsteed, and Barrow. The year Wren was born Galileo was writing his famous "Dialogues," and in the subsequent developments which made England the scientific centre of the world Wren was one of the pioneers. While quite a youth Wren joined the group of philosophers who met at the lodgings of Wilkins or Boyle at Oxford, and at twenty-five he became Gresham professor of astronomy. Four years later he returned to Oxford as Savilian professor. The Royal Society owed much to him, and he was one of its earliest presidents. Perhaps not such an extraordinary boy as Young or Hamilton, his genius was recognised from the first. Barrow indeed, in 1662, referred to him "As one of whom it was doubtful whether he was most to be commended for the divine felicity of his genius or for the sweet humanity of his disposition—formerly as a boy a prodigy; now as a man a miracle, nay, even something superhuman."

Wren was born at East Knoyle, in Wiltshire, on October 20, 1632. His grandfather, Francis Wren, was a mercer in the city of London; his father, also Christopher Wren, was rector of East Knoyle and dean of Windsor. Another son of Francis was Matthew Wren, bishop of Hereford, Norwich, and Ely; a stiff-necked prelate who spent more years in the Tower than he need have done. Wren's mother died when he was young, but his father survived till 1658. At nine Wren was sent to Westminster school, then under the famous Busby. From Westminster, after an interval, probably due to the unsettled state of affairs—Oxford then having more soldiers than students—he passed to the University and was entered as a gentleman commoner of Wadham College, of which Wilkins was the warden. He graduated B.A. in 1651, M.A. in 1653, and that year became a fellow of All Souls, holding his fellowship until 1661, the year he was appointed Savilian professor.

Like most students of his day, Wren roamed over many fields of learning. With a talent for fine and accurate drawing he combined a manipulative skill which was the envy even of Hooke. These found employment in many ways. For Willis he made the elaborate drawings for a work on the anatomy of the brain. He was one of the first to inject liquids into the veins of animals. Writing to Petty in 1656 he says, "The most considerable experiment I have made of late is this;—I injected wine and ale into the mass of blood in a living dog, by a vein. . . . I am in further pursuit of the experiment, which I take to be of great concernment, and what will give great light to the theory and practise of physic."

Wren's two professorships cover a period of sixteen years—1657 to 1673. The Gresham and Savilian chairs were the first mathematical and astronomical professorships founded in England. One or the other had been held by Briggs, Bainbridge, Turner, Greaves, Gellibrand, and Gunter. Gresham College, London, was the old mansion of Sir Thomas Gresham, which stood on a site stretching between Bishopsgate Street and Old Broad Street. The lodgings of the professors of music and physic and the Reading Hall were close to Bishopsgate Street, but the quarters of the other professors were situated around a large quadrangle. An interesting sketch of the college is given in Weld's "History of the Royal Society." Wren's appointment was owing to Lawrence Rooke exchanging the chair of astronomy for that of geometry, the transfer being due "to a conveniency of the lodgings which opened behind the Reading Hall." Wren's lectures were read the same day as Rooke's and attended by the same auditors. He discoursed on telescopes, eclipses, the planet Saturn, and meteorology, and to this period belong his demonstrations concerning cycloids.

In February 1661 Wren resigned both his Gresham professorship and his fellowship of All Souls and returned to Oxford to succeed Seth Ward as Savilian astronomer. In this position he continued to investigate a wide range of subjects, suggesting self-registering weathercocks, thermometers, and rain-gauges; constructing telescopes for measuring small angles, and making experiments with pendulums. In 1668 he showed his experiments to illustrate the laws of motion by the collision of balls. Newton afterwards writing of the laws of motion said: "Dr. Christopher Wren, knight; John Wallis and Christian Huygens, who are beyond comparison the leading geometers of this age, arrived at the laws of the collision and mutual rebound of two bodies; but their truth was proved by Dr. Wren by experiments on suspended balls in the presence of the Royal Society."

It was while Wren still held the Gresham professorship that the Royal Society came into existence. The first official record was a memorandum of November 28, 1660. This gave the names of the persons who had "mett together at Gresham Colledge to heare Mr. Wren's lecture." After the lecture "they did, according to the usual manner, withdrawe for mutuall converse," and it was agreed upon that "this Company would continue their weekly meeting on Wednesday, at 3 of the clock in the tearme time, at Mr. Rooke's chamber at Gresham Colledge; in the vacation, at Mr. Ball's chamber in the Temple." Wilkins was chairman on this occasion. At the next meeting, December 5, Sir Robert Moray, the first elected president, brought word that the King approved of the Society and would be ready to give encouragement to it. The minutes also record that "Mr. Wren be desired to prepare against the next meeting for the Pendulum Experiment." On December 19 Mr. Wren and Dr. Petty were "desired to consider the philosophy of Shipping, and bring in their thoughts to the company about it."

The Royal Society was further indebted to Wren for drawing up the preamble to the charter of Incorporation in which Charles II. states his determination "to grant our Royal favour, patronage and all due encouragement to this illustrious assembly and so beneficial and laudable an enterprize." The charter was first read on August 13, 1662, and two years later Wren gave an address on the objects to which the Society should devote its energies. He exhorts the members "not to flag in the design since, in a few years, at the beginning, it will hardly come to any visible maturity. . . . The Royal Society should plant crabstocks for posterity to graft on." Lord Brouncker became the first president of the Society after its incorporation, Sir Joseph Williamson succeeded him in 1677, and Wren, who had been knighted in 1673, was elected president in 1680. Boyle had previously declined the honour through "a great tenderness in point of oaths." Wren held office till St. Andrew's Day, 1682.

So far, attention has been directed only to Wren's scientific activities. Soon after his return to Oxford, in 1661, he was invited by Charles II. to act as surveyor-general of His Majesty's works, and from this time dates his career as an architect, which ultimately raised him to the head of the profession. The first building designed by him was the chapel of Pembroke College, Cambridge, erected by his bishop-uncle as a thank-offering for his liberation from the Tower. His next building was the Sheldonian Theatre at Oxford. In 1665 he spent six months in Paris studying the Louvre and other buildings, returning home, as he said, "with nearly all France upon paper." In 1666 came the great fire of London, and with it Wren's opportunity. From September 2 to September 8 the flames swept across the city, and four days later Wren laid a plan for its rebuilding before the King. Immediately afterwards he was appointed "surveyor-general and principal architect for rebuilding the whole city; the cathedral Church of St. Paul; all the parochial churches . . . with other public structures." Wren was then but thirty-four, and in the remaining fifty-seven years of his life he not only designed and erected many important private and public buildings, but some fifty London churches, and also his great masterpiece, St. Paul's Cathedral. Several years were occupied in demolishing the ruins of old St. Paul's, and it was not until 1675, the year Wren built Greenwich Observatory, that the foundation stone of the new cathedral was laid. Thirty-five years later Wren's son put the topmost stone of the lantern into position.

Of the city of London as Wren knew it in his Gresham days but little remains. Wren, if he had had his own way, would have changed its very plan. It was his intention to cut two great arteries from east to west and another from north to south. At the intersections of these thoroughfares would have stood the new St. Paul's and the great public offices. He further designed that a noble quay should flank the Thames from the Tower to the Temple. For better or for worse his plans proved unacceptable, and so to-day it is yet possible to follow some of the footsteps of the old philosophers and to visit their memorials.

Though it escaped the fire, all trace of Gresham's mansion has long since disappeared. St. Helen's Church—sometimes called the Westminster Abbey of the City—where the inmates of Gresham College worshipped, still stands, and within its walls lie the remains of Hooke, Goddard and Gresham. Three of Wren's predecessors in the chair of astronomy, Gellibrand, Foster, and Gunter, were buried in St. Peter le Poer, which stood in Old Broad Street, while Rooke, "the greatest man in England for solid learning," was buried in St. Martin Outwich, from which the monuments were some fifty years ago removed to St. Helen's. Rooke died just before the Royal Society received its charter. Greaves, another Gresham and Savilian astronomer, was buried in St. Benets; John Collins, "the attorney-general of the mathematics," in St. James' Church, near Southwark Bridge, while John Wilkins, first secretary of the Royal Society, and from 1668 bishop of Chester, who died in 1672, was buried in St. Laurence Jewry. This was one of the churches rebuilt by Wren. Wilkins had been rector of the church, and on one occasion he invited Barrow to occupy the pulpit. Barrow preached so well that Richard Baxter declared he "could willingly have been his auditor all day long."

Wren himself lies in the crypt under the south aisle of the choir of St. Paul's. He died on February 25, 1723, and was buried on March 5. The well-known quotation from his epitaph: "Si monumentum requiris, circumspice," now to be seen over the north door of the cathedral, was first carved on the choir screen by Robert Mylne, the builder of the first Southwark Bridge and surveyor of St. Paul's, who lies close to Wren in the crypt.

The grand committee formed by the Royal Institute of British Architects and other bodies interested, to celebrate the bicentenary of the death of Sir Christopher Wren, has arranged for a public commemoration service in St. Paul's Cathedral, on Monday, February 26, at 2.30 P.M., in the course of which an address will be delivered by the Very Rev. W. R. Inge, Dean of St. Paul's. The members of the grand committee, accompanied by the Lord Mayor and Sheriffs, will proceed afterwards to the crypt, where Mr. Paul Waterhouse, president of the Royal Institute of British Architects, and an attaché from the American Embassy in London, on behalf of the Architectural League of New York, will lay wreaths upon the tomb of Sir Christopher Wren. In the evening a Christopher Wren commemoration banquet will be given by the Royal Institute of British Architects at the Hotel Victoria, Northumberland Avenue, and commemorative addresses, dealing with the life and work of Wren, will be delivered.

In addition to these celebrations there will be exhibitions illustrating Wren's work, at the Galleries of the Royal Institute of British Architects, 9 Conduit Street, W.1, on February 26-March 3, and at the Museum, Public Record Office, Chancery Lane, W.C.2, both of which will be open free of charge to the public.

Another interesting proof from overseas of regard for the memory of the great London architect comes from the Architectural Institute of British Columbia, which has arranged to hold, in the largest Anglican church in Vancouver, a memorial service on exactly similar lines to the service which will be held in St. Paul's Cathedral on February 26.

Absolute Measure and the C.G.S. Units.

By Sir George Greenhill.

"What is the matter with physics training for the engineer?" is a question asked to-day. The engineer will answer, "It is the C.G.S. source of arrogance and tyranny," following him even into the engineering laboratory, and his calculations in hydrostatics. He has no use for such minute units, as he works always to terrestrial gravitation measure of his world of existence, and C.G.S. is thrown aside as soon as the young engineer, gunner and navigator is liberated from the tyranny of the lecture and examination room, and he is free to talk and calculate in all the old units familiar to generations.

These C.G.S. units are described in Halsey's "Handbook for Draftsmen" as a "Monument of scientific zeal (misplaced) combined with ignorance of practical requirements." "The object of Weights and Measures is to weigh and measure, not merely to make calculations."

No wonder Prof. Hudson Beare maintained at the British Association at Hull the desirability of keeping the mathematics of the engineer distinct from the examination needs of the Science and Art, or even medical student in his research of a diploma, and that the teacher of engineers should preferably be an engineer himself. If he has to teach physics, it should be industrial physics, in their application on a large scale to constructional needs.

Mach pleaded age and infirmity for taking no hand in the translation of his work, and gave the translator a free hand. The opportunity was seized of making him sponsor of the C.G.S. system, and no other, by the ardent disciples of the Open Court. We find the same fervent advocacy of C.G.S. in our scientific schools over here, compelling even the engineering students to use their microscopic units to the exclusion of all others employed in his practical life.

A rival system, M.M.S. (millimetre — milligram — second), still more minute, was proposed in Germany, and is mentioned by Mach, but this was ironical. In France, Olivier, whose work was reviewed lately in Nature, is pushing the M.T.S. system (metre—tonne—second) as better adapted for large scale work.

The M.K.S. (metre—kilogramme—second) system would suit most practical requirements, but this is rejected by the purist in units because it makes the density of water 1000, kg/m^3, instead of unity. But the advantage here is in keeping the air buoyancy in sight, as a correction of about 1·25 on the last figure of the absolute density, *in vacuo*, as it ought to be tabulated. Suppose it was required to weigh 1 lb. or 1 ton of hydrogen in the scales for an airship; describe your procedure.

Absolute measure was first introduced into dynamical teaching under Prof. Tait in Edinburgh, although Tait never carried his Glasgow colleague with him to a full extent. Gauss had initiated the idea previously as essential in magnetic measurement all over the world.

Tait told us the idea struck him in his struggle with the Definitions in Chapter II of his "Dynamics of a Particle"; and then it burst on him as a revelation of the way out of a theoretical difficulty always a puzzle to him.

The idea fructified, and to-day we find absolute measure universal in all theoretical physics, and the engineer is blamed for sticking to his old gravitation units for mechanics. The electrician, however, is compelled to work absolute in his cosmical electro-magnetism, broadcasting his theoretical results, depending only indirectly on the gravitation of the earth.

In Tait's procedure a change was made in the unit of what was then called mass, changing it from a vague *sui generis* into the Imperial Standard Pound, and then $P = Mf$ implied a new unit of force, for which the name poundal was afterwards discovered, such that the heft of 1 lb. weight was g of these units, poundals. The poundal was thus $1/g$ of the heft-weight of 1 lb., say 1/32, or half an ounce in round numbers. This unit was much too small for the engineer; he has refused to have anything to do with absolute measure, and jeers at the pedantry of calling the poundal a unit of weight, pointing to the precise language of the successive Acts of Parliament, from Nebuchadnezzar and earlier, down to our day.

Weights and Measures Act, 1878.

Imperial Measures of Weight and Capacity.

13. The weight *in vacuo* of the platinum weight mentioned in the first schedule of this Act and by this Act declared the imperial standard pound shall be the legal standard measure of weight and of measure having reference to weight and shall be called the imperial standard pound and shall be the only unit or standard measure of weight from which all weights and all measures having reference to weight shall be ascertained. [*N.B.*—No word mass occurs.]

Any person who sells by any denomination of weight or measure other than one of the imperial weights or measures or some multiple or part thereof, shall be liable to a fine not exceeding forty shillings for every such offence. Printer and publisher are liable for any act in contravention of this section.

So any one giving weight in poundals, in print or writing, would be liable to this fine. No mention is made in this Act of barometer or thermometer reading, required in the definition of the gallon, cubic measure; weight *in vacuo* covers all such ambiguity of its measure, inserted for the first time in the draft of this Act; the omission was a source of great trouble when the need arose for a new Standard Pound.

Not a word in the Act about the attraction of the earth on the pound weight. Nothing is said about the pressure on the bottom of the box containing the pound weight, and the influence of local g, however it may vary down a mine, or up in the air, or away into space from one end of the world to the other.

The pound weight does not alter, brought out of its vacuum into the atmosphere, or even if it was carried away into space to the other end of the universe; it always remains the lump of platinum defined in the Act. At least this was the current belief until quite recently, before a distinction was made between *Ruhmasse* and *Masse in Bewegung*.

If, however, the weight of a pound is to mean something quite distinct from the pound weight, as the force with which it is attracted by the earth, the confusion of language and measurement is intolerable.

It is not correct to say the word weight is always to be reserved, strictly speaking, for the subsidiary meaning of earth attraction, as the word was in use long before such distinction was made or understood, and is to be found in ordinary language and writing, *e.g.* in Shakespeare, the Bible, and other of our classics, in both senses, but usually in the meaning of the Act of Parliament.

The latest discoveries of atomic theory have forced a reconsideration of former definitions of fundamental units, considered unassailable on the Newtonian doctrine. Language again has failed to recognise these new distinctions. C.G.S. units are displaced in the relativity theory, where the unit of time is nearly 1000 years, instead of our terrestrial second, adopted to keep g down to a reasonable figure, 981, or 32.

"Space-Time-Matter" of Hermann Weyl will give some idea of the latest lofty ideas of the universe, beyond the scope of these humble elementary remarks in defence of the old Newtonian mechanics—all the engineer has, so far, to guide him in the design of the steamship, locomotive, and flying machine. Here he is forced to adopt some immediate line of action, leaving the abstract theorist to pursue his speculations at leisure. The engineer must deliver the goods to time.

The *sui generis* mass $M = W/g$, Mach's terrestrial mass, implies unit mass of g, lb.; Perry proposed for it the name "slug," about a 32 lb. shot. But slug in gunnery means any irregular piece of lead, cut off a church roof in civil war, and rammed down a fowling piece. It is curious to find *sui generis* mass in slugs still lurking in the engineers' table of moment of inertia of a body; it has even been found by force of habit in a cross-section area for moment of stiffness of a beam.

There is too much of the mere algebraical literal calculus in the presentation of dynamical theorems. Quantities receive a label, M, W, g, v, s, t, as in mere algebra, and this letter label is stuck on the quantity for identification, without sufficient explanation of the measurements required to translate the label into the description of an actual body, or its behaviour in motion and associated measurement.

But the writer of the usual text-book is obliged to keep in mind the needs of his class in preparing to meet the examiner, or is on the road to be an examiner himself in his turn, and his book adopted. So the round goes on, and a curious jargon has arisen, cultivated by the schoolmaster and despised by the engineer.

Darboux surprised our company once by retailing the well-known story of the French Minister of Education, pulling out his watch and boasting how at that moment the same lesson was in progress in all the schools in France. I was so bold as to cut in—"Mais, il y a une suite." "Quelle suite?" "Le ministre a continué,—du même traité, de moi."

The Hospitalier notation is a ready escape from confusion when the derived unit appears, involving two or more of the three fundamental units. Then a velocity in feet or centimetres per second is indicated by v, ft./sec. or cm./sec., and an alteration of velocity per second by ft./sec.^{2} or cm./sec.^{2}; thus $g = 32{\cdot}2$, ft./sec.^{2}, or 9·81, m./sec.^{2} So, too, for density, in lb./ft.^{3}, gm./cm.^{3}, kg/m.^{3}, t./m.^{3}. A moment of inertia, Wk^2, would be in lb./ft.^{2}, and so on. But the adoption of this Hospitalier system is still very slow, although accepted by a resolution of the Paris Electrical Congress, 1880, and again at Frankfurt, 1891.

Although absolute measure of force is insisted on in all C.G.S. records, there is no accurate measurement of force except first in the gravitation unit of the gravity field, as with the Current Weigher-Balance; and after the experiment is complete, the factor g is to be supplied, but often forgotten.

Rayleigh appears to be writing feelingly, quoted in *Engineering*, July 4, 1919: "When a problem depends essentially on gravity, g makes no appearance. But when gravity does not enter at all, g obtrudes itself conspicuously, and requires to be kept carefully in its proper place" (as in electro-magnetic and elastic measurement).

All matter is transparent to gravity: there is no escape from it on the surface of the earth. In the work of the engineer to combat the powers of Nature, gravity is the force he is up against, and the strength of it provides him with the unit the engineer will never discard, as capable of immediate exact measurement. He will never abandon his gravitation units for such minute substitutes in the C.G.S. system, useful only for passing an examination, or for microscopic physical measurement.

Weighing and measuring must be carried out in a gravity field, and not *in vacuo*; the experimenter must be allowed to breathe in a warm room during a long careful measurement. The factor g is inserted after the work is over, for calculation and record in absolute measure, and the C.G.S. system was invented to make calculations and tabulate them, not to weigh and measure, as Halsey pointed out.

The metric system is a legacy of the French Revolution, when all ancient tradition was swept away and the world to be started going afresh. Time and angle were to be decimalised with French logic. The quadrant was divided into 100 grades, each of 100 centesimal minutes; and a minute on the meridian was made into the kilometre—the unit of distance. But sexagesimal clocks, watches, and chronometers were not to be thrown into the sea for such a theoretical fad as centesimal time; and the ridiculous official names assigned to the days of a decimal week excited derision. Any attempt was bound to fail to bring music into line with the metric system, by a decimalisation of the octave.

Elsewhere the metric system has taken a firm hold in the civilised world, as a means of cosmopolitan commercial intercourse, and must be accepted. But the sailor will not surrender his cosmopolitan sexagesimal measure, of time and angle, inherited from the Chaldæan astronomer, and he continues to graduate the quadrant into ninety degrees, and the degree into sixty minutes, and he takes the sexagesimal minute of latitude on the meridian as his unit of length, and calls it a mile, geographical (G), nautical (N), sea (S), or Italian, in the old books.

The sailor then starts a decimal subdivision of the mile, dividing it into 10 cable, and the cable into 100 fathom. Geodetical measurement makes this fathom a little more than 6 ft.,—6·08, say 6 ft. and 1 inch over. Longitude he measures on his chronometer, giving sexagesimal time of 24 hours (h.) in the day, an hour of 60 minutes (m.); and a minute of 60 seconds (s.); four seconds of longitude = one minute of longitude at the equator, or a mile, an easy range of eyesight. The schoolmaster cuts the fathom down to 6 ft. exactly, and would sweep it away as a useless load on the schoolboy's memory, although universal in sounding, as in

"Full fathom five thy father lies."

The schoolmaster has his eye, too, on the suppression of all the ancient measures of agriculture,—furlong, rod, pole, perch, rood, chain, ell, palm, hand. But the chain as the length of the pitch at cricket is too sacred to be assailed. And what is the height in C.G.S. centimetres of a horse x hands high? He is obliged to cling to the mile, the statute, land, military mile, of 8 furlongs, 80 chains, or 1760 yards.

It is unfortunate the sailor carried the world mile on to his own unit, perhaps under a mistaken idea that the two miles were undistinguishable. Newton was arrested in his speculation on gravity by falling into this error. The land soldier mile is the one entitled to its name as the length of 1000 paces (*passus*, not *gradus*), *millia passum*, M.P. on the Roman milestone, covered in marching along the road, making 5·28 ft. the double pace of the Roman soldier; this is cut down to 5 ft. in our modern drill book, and less still in the metric equivalent of the French soldier.

It is strange to read to-day in the "Admiralty Manual of Navigation," 1914, page 1, the earth is described as an oblate spheroid, greatest and least *diameter* 3963, 3950 miles (military, soldier, statute). In navigation the surface of the ocean is always treated as a perfect sphere, and of girth $360 \times 60 = 21600$ sea miles (S), making the *radius* of the sphere 3438 S miles, the length of the radian along a meridian. Besides the solecism of mentioning the military land mile as a measure in navigation, the real dimensions of the earth are double as stated in the Manual. Can we wonder then at an Admiral sending himself and his flagship to the bottom by a confusion between radius and diameter?

The Royal Society.

MUNIFICENT GIFT FROM SIR ALFRED YARROW.

THE generous gift from Sir Alfred Yarrow, announced in the subjoined letter from him to the president of the Royal Society, and gratefully accepted by the Society, is a most welcome acknowledgment from a great leader of industry of the practical service of scientific investigation. Sir Alfred, who was elected a fellow of the Society last year, has always taken an active interest in the progress of science and has promoted its application to industry in many ways—directly in his own works and indirectly by gifts to educational and scientific institutions. His faith in science as the maker of the modern world is unbounded, and the words in which he gives expression to it should afford scientific workers both pride and encouragement. We are at the beginning of a new era of human history, and it is to the close association of science and industry, in the spirit of Sir Alfred Yarrow's letter, that we must look for strength to meet the difficulties before us. The Royal Society, and the scientific workers it represents, may be trusted to continue to extend the boundaries of natural knowledge, and if statesmen and industrialists have the same progressive aims we can look with confidence to whatever the future may bring.

I would ask you to be so kind as to bring before the Council, at an early opportunity, the following proposals:

I have, for many years, held the view that the prosperity of this country has been greatly hampered in the past for the want of better promotion to scientific investigation and its application to practical affairs.

I am convinced that the future prosperity of this country will be largely dependent upon the encouragement of original scientific research. The birth of new industries, and the development of existing ones, are due largely to the growth of science, thus securing employment and the welfare of the whole community being advanced.

It is doubtful whether even yet it has been realised how completely this country would have been at the mercy of our antagonists in the late war, had it not been for the research work done by our scientific men before the war and during its course.

I desire to mark my sense of the value of research to the community by offering, as a gift to the Royal Society, 100,000*l.* to be used as capital or income for the purposes of the Society, as the Council may think fit, because I recognise conditions alter so materially from time to time that, in order to secure the greatest possible benefit from such a fund, it must be administered with unfettered discretion by the best people from time to time available.

Care must, of course, be taken that a gift from the fund shall in no case lessen any Government grant.

In accordance with your practice you would, I assume, appoint a Committee to administer the fund, and would also frame rules for the guidance of the Committee, while reserving the right to alter such rules from time to time; and I would suggest that they be reconsidered by the Council every tenth year so as to meet modern needs.

I should prefer that the money be used to aid scientific workers by adequate payment, and by the supply of apparatus or other facilities, rather than to erect costly buildings, because large sums of money are sometimes spent on buildings without adequate endowment, and the investigators are embarrassed by financial anxieties.

Although I thus give a general expression of my wishes, I do not intend, by so doing, to create any Trust or legal obligation for their fulfilment.

In conclusion, I should like to record my firm conviction that a patriotic citizen cannot give money, or leave it at his death, to better advantage than towards the development of science, upon which the industrial success of the country so largely depends.

A. F. YARROW.

Obituary.

Prof. W. K. von Röntgen.

It is given to few men of science to make a contribution to knowledge which compels world-wide interest from its first announcement. The late Prof. Röntgen's discovery of the X-rays in 1895 was not only of the first importance, but also enjoyed the distinction of finding an immediate and immense field of application in surgery and medicine. Presently they were destined to play also a prominent part in the extraordinary developments in atomic and molecular physics which have characterised the last twenty years—developments which make it safe to assert that at no period in its history has physical science been more effective and wide-reaching in its fundamental activities. Röntgen was happily spared to be a witness of all this, and although his contributions to X-ray research ceased some years ago, his satisfaction at the growth of the subject can have been in no way diminished.

Wilhelm Konrad von Röntgen was born at Lennep in the Rhineland on March 27, 1845. Although a German by birth, he was sent to school in Holland, and later he took his doctor's degree in Switzerland at Zurich in 1869. Then he was appointed assistant to Kundt at Würzburg in Bavaria, and afterwards at Strasbourg, where he carried out a well-known piece of work on the ratio of the specific heats of gases. He became a privat-dozent of the latter University in 1874. A brief period followed as professor of mathematics and physics at the Agricultural Academy at Hohenheim, after which he returned to Strasbourg in 1876 as extra-ordinary professor of physics. In 1879 he became professor of physics and director of the Physical Institute at Giessen; and six years later followed his appointment to the chair at Würzburg. It was here he made his famous discovery. Afterwards he was appointed to the chair of experimental physics and director of the Physical Institute at Munich; he resigned these appointments in 1919. Röntgen died at Munich on February 10, 1923, at the ripe age of seventy-eight years. He received the Nobel Prize for physics in 1901, and with Prof. Lenard the Rumford medal of the Royal Society in 1896.

While Röntgen's researches extended over a fair range of physics, their importance is completely overshadowed by his discovery of the X-rays, the credit for which is in no way lessened, but rather is enhanced by the curious belatedness of the event. Crookes, during his memorable investigations (1879–85), constructed a discharge tube with a concave cathode and a platinum target to display the heating effects of focussed cathode rays. Thus all the essential features of a modern gas X-ray tube were there, and X-rays must have been generated in abundance, but, although much of value *within* the tube was noted and recorded, the X-rays remained unnoticed.

Later Lenard, in 1894, demonstrated conclusively that cathode rays could pass through a thin window of aluminium, and were able to excite phosphorescence a few millimetres away in air. This was a correct observation, despite the fact that we now know that part of the phosphorescence was due to X-rays excited by the aluminium. About this time the inexplicable fogging of unopened packets of photographic plates in the neighbourhood of excited Crookes tubes was engaging the attention of more than one English physicist, but not until the autumn of the following year was the major discovery made by Röntgen, the manner of it being somewhat accidental. It so happened that in a search for invisible light rays he had enclosed a discharge tube in light-proof paper, and, to his surprise, noticed that, when the tube was excited, a barium platinocyanide screen lying on a table a few metres distant shone out brightly. If obstacles were interposed between the tube and the screen they cast shadows, and very quickly a unique and fascinating feature was revealed—the new or "X"-rays could penetrate many substances quite opaque to light. The degree of penetration depended on the density; for example, bone was more absorbent than flesh. When Röntgen communicated his results to the Physico-Medical Society of Würzburg in November 1895, the immense significance of his discovery received universal appreciation. A translation of his paper appeared in the issue of NATURE for January 23, 1896 (vol. 53, p. 274).

An army of workers sprang up and a torrential output of observations and speculation followed, as a glance at the scientific journals of those days will verify. The Röntgen Society came into being in London in 1897, largely at the instance of the late Silvanus Thompson, and similar societies were inaugurated later in other countries. Röntgen himself contributed three memoirs to the subject during these years, but later returned to his earlier interests in physics. He had, with others, established the fact of the ionising properties of the X-rays.

Much controversy and a wealth of speculation followed as to the nature of the rays. But experiment gradually whittled down the various theories, and no question now arises that the X-rays are light rays with wave-lengths which place them next to, and beyond, the ultra-violet. It was their minuteness of wave-length that defeated all the earlier attempts to sort out the rays, and this uncertainty continued until Nature herself was found to have fashioned suitable diffraction gratings in the form of crystals, the regular atomic spacings in which were of the right order of magnitude. We can now claim a knowledge of the existence of more than thirteen octaves of X-rays. Of these, three octaves or so are used by the radiologist, these having wave-lengths of the order of 10^{-8} cm.

We can only refer briefly to the enormous application of the X-rays in medicine. It is probable that no more potent weapon has been put into the hands of the medical man. The late war brought this home in unexampled fashion, and while human endeavour reached its pinnacle in almost every phase of life, it is difficult to overestimate the services which Röntgen's discovery rendered to humanity. An extensive industry in X-ray equipment has sprung up in this country and abroad.

The new knowledge was not without its menace, as many of the pioneers discovered to their cost. Prolonged and frequent exposure was found to produce a disastrous effect on human tissue. But the conditions of danger and the means of avoiding them were gradually ascertained, and recently, thanks to the recent work of the X-ray and Radium Protection Committee, under the chairmanship of Sir Humphry Rolleston, president of the Royal College of Physicians, the necessary precautions have been widely circulated. In the light of a fuller knowledge the destructive effect of the rays has been turned to account by taking advantage of their selective action when applied to superficial and deep-seated growths in the tissue.

The X-rays have also found extensive industrial application to detect flaws and impurities, and in many other directions.

As already mentioned, the X-rays have proved of the greatest importance in recent developments of fundamental physics. We owe to them Moseley's arrangement of the elements in the order of their atomic numbers, a quantity determined by the atomic nucleus. The wonderful results of Sir William Bragg and his son on crystalline structure rest wholly on X-ray measurements. Much of the work which under Sir J. J. Thomson and Sir Ernest Rutherford has made the Cavendish Laboratory world-famous has dealt with X-ray and kindred phenomena.

At the close of Röntgen's life, we may well pause to survey the goodly harvest that science has reaped from the event with which his name will be for ever associated. Hard on the heels of his discovery came that of the electron by J. J. Thomson and of radioactivity by Becquerel. The new chapter of physics which was thus unfolded has already had the most profound effect on everyday life. G. W. C. K.

Mr. Bernard Bosanquet.

Mr. Bernard Bosanquet, who died on February 8, after a short illness at his home at Hampstead, to which he had moved a few months ago, has occupied for more than a generation a foremost place in English intellectual life. For the last ten years his health has required him to refuse public engagements, but he continued to be as assiduous in literary productions as during any period of his active life. He was at work till the end, and we are told that he left an uncompleted book on his desk, of which, however, three chapters are finished. The intended title was "What is Mind?" He was an ardent philosopher, who cared little for the brilliance of a speculation and nothing whatever for originality or ownership of ideas, but sought the truth concerning human life and the meaning of experience with an earnestness which seemed like the devotion of a religious mission.

Born in 1848, Mr. Bosanquet was educated at Harrow and at Balliol College, Oxford, and after graduating spent ten years at Oxford as fellow and tutor of University College. In 1881 he came to London and threw himself ardently into the work of the Charity Organisation Society and the Ethical Society, and also lectured on ancient and modern philosophy for the University Extension centres in London.

His "Logic, or Morphology of Knowledge" is a classic. It was published in 1888, and carried out with systematic thoroughness the new principle of an inner activity of thought which had already found expression in Mr. F. H. Bradley's polemic against the formalism and associationism of the empirical school. The next large work was "A History of Æsthetic" in 1892. In 1912–1913 were published the two volumes of Gifford Lectures, the first on "The Principle of Individuality and Value," the second on "The Value and Destiny of the Individual." It was in these lectures that he worked out his philosophical theory of the meaning of life. "This universe," he said, borrowing a phrase from Keats, "is the vale of soul-making." These volumes constitute one of the profoundest works of pure philosophy of the modern period.

Mr. Bosanquet was a man of great personal charm. Dialectic, in the Socratic meaning, was the joy of life to him, but he was always sympathetic to the opposer, genuinely eager to understand his point of view, and always anxious to appreciate its value. Yet no one was firmer or more tenacious in argument. He never expounded any theory or defended any position unless his whole heart was in it, and unless he was convinced of its truth.

Mr. Bosanquet kept himself fully abreast of all the intellectual movements of his time. He was thoroughly acquainted with the philosophical thought of Germany, and he was deeply interested in the new movement in Italian philosophy, the idealisms of Croce and Gentile, though dissenting from them on essential points. His knowledge of Italian was thorough, and only a few months ago he contributed an article in Italian to Prof. Gentile's *Giornale critico*. He was not attracted by the modern French philosophy, which he could never come to regard as other than superficial. The reason for this, no doubt, was that the approach to philosophy through the problems of science, the fundamental questions of mathematics, physics and physiology, which is especially distinctive of French philosophy, seemed to him less important and less compelling than the ethical approach.

Besides the important works mentioned, Mr. Bosanquet wrote numerous smaller books, many of striking originality and value; of these we may mention "The Philosophical Theory of the State" and two quite recent books, "The Meeting of Extremes in Contemporary Philosophy," 1921, and "Implication and Linear Inference," 1920.

For five years, 1903–1908, Mr. Bosanquet was professor of moral philosophy at St. Andrews. He was an original fellow of the British Academy, and was president of the Aristotelian Society from 1894 to 1898. He received the honorary degree of LL.D. from the University of Glasgow, and of D.C.L. from the University of Durham.

Mr Bosanquet married, in 1895, Miss Helen Dendy, a sister of Prof. Arthur Dendy, of King's College, London. Mrs. Bosanquet served on the Royal Commission of Inquiry into the Poor Law. She is the translator of Sigwart's "Logic" and the author of several books on social and economical questions.

Dr. A. H. Fison.

The staff of Guy's had subscribed money for a wireless installation to illustrate Dr. Alfred Henry Fison's lectures, and for the use of the hospital in other ways. On February 1, when on the roof by himself, attaching an aerial, Dr. Fison fell through a skylight to the floor below. Three days later he died without regaining consciousness.

Dr. Fison's life-story is that of a teacher whose enjoyment in knowing was so vivid that no delight could equal that of passing his knowledge on. In his earlier life he had for twenty years lectured for the Oxford University Extension Delegacy; and this is a school in which the spirit of enthusiasm for knowledge is engendered. If an extension lecturer be not in complete sympathy with his audience, if he has not the instinct for detecting want of harmony between his mind and theirs, his lectures are a failure; his thought-waves must be of the length for which his auditors' receivers are tuned.

From 1912 until his death Dr. Fison was Secretary to the Gilchrist Trust. Each year in the spring he visited various parts of Britain to inspire enthusiasm and to organise local arrangements; in the autumn and winter to deliver lectures. His efforts to fill successfully the gaps caused by death in the Gilchrist staff discovered to him how very rare are the men who have the gift which he possessed of securing in their first few sentences the complete confidence of their audiences and retaining their strained attention for eighty or ninety minutes—halls crammed with people of all sorts and conditions, from the clergy, doctors, and schoolmasters of the town to miners and mill-hands—sending them away with the feeling that the evening which had closed a long day's work had altered their views of the world and had, at the same time, entertained them hugely.

In 1906 Dr. Fison was appointed lecturer in physics to Guy's Hospital, and somewhat later to the London Hospital also. Although his teaching work was elementary, he held that no teacher can be efficient who does not follow the most recent developments of his subject. He was a sound scholar—in the sense in which the expression is used by students of the humanities who are disposed to arrogate it to themselves. The very large gathering of students at the memorial service in the Chapel of Guy's was a measure of his success. Shortly before the accident brought his activities to a sudden close he talked to the writer of these notes of his plans for an early retirement and the devotion of his remaining days to investigations for which his duties as a teacher had left him but scanty leisure, and the publication of his reflections—his bent was ever towards philosophy—upon various aspects presented by the problems of physical science. His best-known contributions are "Recent Advances in Astronomy" (1898) and "A Textbook of Practical Physics" (1911, rewritten 1922).

Mr. Rawdon Levett.

The death at Colwyn Bay on February 1 of Mr. Rawdon Levett, at seventy-eight years of age, will be regretted by none more than by the members of the Mathematical Association, of which, under its old name of the Association for the Improvement of Geometrical Teaching, he was one of the original founders. From his pen, in Nature, of December 29, 1870, p. 169, first came the suggestion that such an Association should be formed, and the first conference was held at University College, London, on January 17, 1871. Levett possessed much more than the driving power and organising capacity which made him so successful a secretary in the first twelve years of the Association. Unlike most of his contemporaries he had familiarised himself with the continental text-books and with the methodology of his subject as taught in France, Germany, and Italy. The ideas of non-Euclidean geometry found in him an apt exponent to any who cared in those days to listen to him, and in the revolution that was to come in the fields of geometry and analysis he played for a time a prominent part. His "Elements of Trigonometry," which he brought out in collaboration with Dr. Davison in 1892, shows how much he had been influenced by De Morgan, by Cauchy and the continental school, and by Chrystal—and in that case the influence had been reciprocal.

The name of Canon J. M. Wilson has stood for half a century with that of Rawdon Levett on the list of officers or of vice-presidents of their Association. Both were at St. John's; Wilson was Senior in 1859; Levett was 11th Wrangler in 1865 (Rayleigh's year). Both were schoolmasters, Wilson in those days at Rugby, and Levett at King Edward's School, Birmingham. Both have retained their interest in the work of the Association, though ill-health had for many years past prevented Levett from taking any active part in its later history. The interests of neither were restricted to the sphere in which their academic honours were won.

Levett was a man of wide reading and general culture. By many his name was probably seen for the first time on the dedicatory page of "John Inglesant"—"I dedicate this volume to you that I may have an opportunity of calling myself your friend." The spiritual kinship that knit together men like Levett and Shorthouse indicates but one of the intellectual influences that brought to the Birmingham schoolmaster intimate relations with a wide circle of men who appreciated to the full his noble character, rare judgment, and fine literary instinct. Birmingham was the poorer by his loss when the shadow of the White Scourge fell upon him in 1903, and he retired to his Welsh home at Colwyn Bay. Now he is gone, and the only founders left are Canon Wilson, Mr. A. A. Bourne, Sir Thomas Muir, the Rev. E. F. M. MacCarthy (secretary for seven years), and the Rev. W. H. Laverty.

W. J. G.

Prof. Gaston Bonnier.

We regret to announce the recent death at Paris of Prof. Gaston Bonnier, professor of botany at the Sorbonne, member of the Institute (Académie des Sciences), of the Academy of Agriculture and the Council of the University of Paris, Officier de la Légion d'Honneur, foreign member of the Linnæan Society of London, and member of many other scientific bodies.

Prof. Bonnier was the president of the Société Botanique de France, and editor of the *Revue générale de Botanique*, founded by him in 1889. Among his numerous botanical publications that have become classic may be particularly mentioned his "Cours de botanique," "Géographie botanique et la botanique descriptive," "Flore complète de la France," "Nouvelle Flore des environs de Paris," and "Flore du nord de la France et de la Belgique." His published research on the correlation of function, form and structure of plant organs is as remarkable for its simplicity and clearness of style as for its scientific value. His journalistic contributions to *Le Temps* were appreciated by all its readers.

Prof. Bonnier played a most important part in the reform and extension of the teaching of the natural sciences in France. To his students and research workers, including men and women of many nationalities, he was friend, guide and master.

The French president, the University of Paris, and many scientific bodies were represented at the obsequies, which took place with military honours.

Current Topics and Events.

On February 14, Mr. Fisher presented to the House of Commons the usual petition from the Trustees of the British Museum praying for further support. Though this is merely a form arising out of the peculiar mode of government of the museum, we may be permitted on this occasion to emphasise the desirability of doing nothing that should hinder the performance of this trust "for the general benefit of learning and useful knowledge." The British Museum, a term which includes the Natural History Departments, is not one of those Government establishments that swelled its ranks and its expenses under stress of war, nor has it shown a reluctance to reduce them in the difficult times of peace. On the contrary, it has only just brought its scientific staff back to the pre-war level, and it has conscientiously reduced its estimates as required by the Geddes Commission. Its scientific publication is almost, if not entirely, suspended. This is a state of affairs we may lament, but must endure. What we are not prepared to suffer without protest is any further demand for reduction. There are rumours of such a demand, amounting to several thousands of pounds. This could only result in a diminution of the valuable work accomplished by this great establishment, work already most seriously hampered by the inadequate size of the staff. To choke one of the great founts of "learning and useful knowledge" can never be an economical proceeding, and any attempt to do so will meet with the united protest of all scientific workers.

The Home Secretary has appointed a committee to inquire into the desirability of extending the Workmen's Compensation (Silicosis) Act of 1918, which provides compensation for men injured by silica in specified industries. The association of miner's phthisis (fibrosis of the lungs with superadded tuberculosis) with the inhalation of hard dust, as in quartz mining or knife grinding, has long been known, and its recognition has led to the introduction of appropriate preventive measures. Collis pointed out that the danger of a dust was in proportion to its content of free silica, and Mavrogordato found that coal dust was actually an antidote when mixed with rock dust, which by itself was highly injurious. Later experiments by Gye and Kettle have shown that the action of silica is chemical rather than mechanical, and that colloidal silica is distinctly poisonous. Chronic silica poisoning in rabbits causes degenerative changes in the liver and kidneys, and, though the applicability of these results to the occurrence of similar lesions in men is at present quite an open question, it is evident that the harmful effects of this common substance may prove to be much more widespread than is at present supposed.

The New York correspondent of the *Times*, in the issue of February 13, refers to some successful experiments upon the dissipation of clouds by the Army Air Service of the United States at Dayton, Ohio, under the direction of Prof. Bancroft of Cornell University and Mr. Francis Warren. The process consists in scattering electrified sand with the propeller of an aeroplane moving 500 ft. above the tops of clouds. The sand is said to be charged to 10,000 volts, and the result is referred to in the headline of the note as "rain-making." The coalescence of the cloud particles in consequence of the diminution of surface-tension is suggested as the proximate cause of the disappearance of the clouds, which are stated to have varied from several thousand feet to several miles in length and breadth, and in thickness from 500 ft. to 1500 ft. The general conclusion of the correspondent is that fogs "need be no more and, given only clouds, rain can be had wherever it is wanted." An important question is, of course, how much? "The time required to precipitate the moisture . . . rarely exceeded ten minutes," and in the case of very thin clouds the moisture evaporated before reaching the ground. Further particulars will be awaited with interest. In the meantime the announcement brings once more into prominence the need for special laboratories for the practical physics of the atmosphere, for which a good deal of work has long been waiting. The coalescence of water-drops, the correlative pulverisation of water and their relation to electrification, are not by any means fully explored. The energy-relations are very complicated. It is known, for example, that a bucketful of water tossed out of an aeroplane would be pulverised into an electrified cloud by its own gravitational energy. To get it back again into a continuous mass of water at the ground by the use of electrified sand will be a very interesting completion of the cycle when we understand it.

A telegram recently received at the Linnean Society from Tiflis announced that an eminent foreign member of the Society, Prof. Serge Gabrilovitch Navashin, of the Botanic Garden, Tiflis, Georgia, was to celebrate on February 18 his fortieth year of scientific work and the twenty-fifth anniversary of his announcement of double fertilisation in plants. This message recalls the new era in the study of the embryogeny of the flowering plants which followed

Treub's discovery of chalazogamy in Casuarina in 1891. Two years later Navashin reported a similar unusual course of the pollen-tube in the birch, and his own work and that of others supplied new instances. In 1898 Navashin announced at the meeting of the Russian Society of Naturalists his discovery, in species of Lilium and Fritillaria, of what at once became known as "double fertilisation"—the fact that, of the two male nuclei which enter the embryo-sac, one fuses with the egg-cell, the joint product being the embryo, while the other fuses with the two polar nuclei of the embryo-sac, either before or after their union, the product of this fusion being the endosperm, which supplies a store of nourishment in the seed for the embryo. The discovery was rapidly confirmed and extended by Navashin and others, and the occurrence was shown to be frequent if not general in the flowering plants. It gave a new interest to the discussion as to the true nature of endosperm, and, incidentally, provided an explanation of "xenia," or the occurrence outside the embryo of characters derived from the male parent. Notable contributions to this discussion were made by Strasburger, Miss Sargent, and others, but the problem still awaits a satisfactory solution.

THE Right Hon. T. R. Ferens, High Steward of Hull, has consented to accept the office of president of the thirty-fourth congress of the Royal Sanitary Institute, to be held at Hull on July 30–August 4.

SIR CHARLES PARSONS, honorary member of the Institution of Electrical Engineers, has been awarded the Faraday medal of the Institution. The medal is awarded for "notable scientific or industrial achievement in Electrical Engineering, or for conspicuous service rendered to the advancement of electrical science."

IN the *Observer* for February 18 it is recorded that "A Lahore telegram says that a meteorite, which was clearly seen in January in most of northern India, was traced at Quetta, where it buried itself. The remains show that at the time of impact it must have weighed six tons."

IT has now been announced that the donor of 5000*l*. to the Rowett Animal Nutrition Research Institute at Aberdeen is Mr. Walter Reid of Aberdeen. Other recent contributions include one of 500*l*. from the Highland Agricultural Society of Scotland.

WE learn from the *Scientific Monthly* that Dr. Robert A. Millikan, of the California Institute of Technology, Pasadena, has been awarded the 1922 Edison medal of the American Institute of Electrical Engineers for "meritorious experimental achievement in electrical science."

THE committee for the jubilee of Prof. Kamerlingh Onnes on November 11 last, which issued the memorial volume of the Physical Laboratory at Leyden, 1904–1922, announces that a limited number of copies of the volume is still available; copies may be obtained at the price of ten florins on application to the treasurer of the committee, Dr. H. R. Woltjer, Natuurkundig Laboratorium, Leyden, Holland.

ON Tuesday, February 27, at 3 o'clock, Sir Arthur E. Shipley will deliver the first of two lectures at the Royal Institution on life and its rhythms, and on Thursday, March 1, Mr. Theodore Stevens will begin a course of two lectures on water power of the Empire. The Friday evening discourse on March 2 will be delivered by Dr. G. C. Simpson on the water in the atmosphere, and on March 9 by Dr. C. W. Saleeby on sunlight and disease.

BY arrangement with the grand committee of the Royal Institute of British Architects in charge of the bicentenary celebrations of Sir Christopher Wren, Messrs. Hodder and Stoughton will issue on February 26 a memorial volume, dealing with various aspects of Sir Christopher Wren's life and work, under the general editorship of Mr. Rudolf Dircks, librarian of the Royal Institute of British Architects. The volume is being published at five guineas and upwards, and all the profits from its sale will be handed over to the St. Paul's Cathedral Preservation Fund.

AN exhibit of special interest at the present time will be found in Museum No. I. at Kew Gardens, in Case 128 on the ground floor. It consists of a collection of funeral wreaths, garlands, flowers, leaves, fruits, seeds, etc., in excellent preservation from ancient Egyptian tombs, including those of Aahmes I. and Rameses II., kings of Egypt of dates respectively 1700 B.C. and 11–1200 B.C. The flowers chiefly used are those of *Nymphæa cærulea*, *Acacia arabica*, var. *nilotica*, together with leaves of *Mimusops Schimperi* and *Salix Safsaf*. It may be noted that the various flowers, seeds, etc., are identical with those of the same species found growing at the present day.

AT the annual general meeting of the Society of Public Analysts held on February 7, the following officers and council were elected for the ensuing year:—*President*: P. A. Ellis Richards. *Past-Presidents*: Leonard Archbutt, A. Chaston Chapman, Bernard Dyer, Otto Hehner, S. Rideal, A. Smetham, E. W. Voelcker, and J. Augustus Voelcker. *Vice-Presidents*: F. W. F. Arnaud, F. H. Carr, and G. W. Monier-Williams. *Hon. Treasurer*: Edward Hinks. *Hon. Secretary*: E. Richards Bolton. *Assistant Hon. Secretary*: R. G. Pelly. *Other Members of Council*: H. Ballantyne, S. F. Burford, S. Elliott, B. S. Evans, E. M. Hawkins, Harri Heap, H. F. E. Hulton, Andrew More, A. E. Parkes, W. R. Schoeller, G. R. Thompson, and J. F. Tocher.

THE following officers and other members of Council of the Royal Meteorological Society were elected at the annual general meeting on January 17:—*President*: Dr. C. Chree. *Vice-Presidents*: Mr. R. H. Hooker, Dr. A. Crichton Mitchell, Dr. G. C. Simpson, Dr. G. T. Walker. *Treasurer*: Mr. W. Vaux Graham. *Secretaries*: Mr. J. S. Dines, Mr. L. F. Richardson, Mr. G. Thomson. *Foreign Secretary*: Mr. R. G. K. Lempfert. *Councillors*: Mr. C. E. P. Brooks, Dr. John Brownlee, Mr. David Brunt, Capt. C. J. P. Cave, Mr. J. E. Clark, Mr. R. Corless, Mr. F. Druce, Col. H. G. Lyons, Mr. H. Mellish, Sir Napier Shaw, and Mr. F. J. W. Whipple. *Assistant Secretary*: Mr. A. Hampton Brown, 49 Cromwell Road, South Kensington, S.W.7.

The Journal of the Camera Club, which first appeared in 1886 and was issued at regular intervals for twenty years, was one of the foremost of publications connected with photography. The authorities of the Club feel that the time is now ripe to begin a new series. It has been decided to issue the Journal quarterly, and that it shall contain summaries of lectures given before the Club as well as articles on photographic subjects. The first number has just been published, and contains among its many items technical articles by Dr. Alexander Scott, Mr. Chapman Jones, and others. The whole number is interesting, even to non-members of the Club, to whom its price is 6*d*.

The Ministry of Agriculture is able to announce, as the result of conferences held at Washington in May and October last, that bulbs of Chionodoxa, Galanthus, Scilla, *Fritillaria imperialis*, *F. Meleagris*, Muscari, Ixia and Eranthis, have been added to the list of bulbs permitted unlimited entry into the United States, the permission holding good for a period of three years from January 1 last. The activities of the phytopathological service of the various countries at the ports continue to increase; bulbs now reach this country from Holland guaranteed by the inspection services of the Netherland Government. British potatoes may receive certificate of immunity after trial at the official station of the Ministry of Agriculture and Fisheries at Ormskirk, and the British phytopathological services receive increasing demands for inspection service before export. In the present state of our knowledge of plant pathology the requirements of these services raise many problems requiring further research; thus it is very difficult to say in the case of transplanted stocks, whether a swollen structure at the base is a somewhat excessive callus or a form of crown gall. Such questions seem to indicate the advisability of leisurely inspection at the nursery before despatch rather than examination at the port just before shipping. This plan is largely adopted, and recalls to mind the advantages and disadvantages of the Central Passport or Permit Offices which dealt with civilian travellers during the war.

The eighth Bulletin of the Non-Ferrous Metals Research Association contains much valuable material. Good progress is being made with the systematic researches undertaken on behalf of the Association, and an extensive investigation is now planned, dealing with the subject of die-casting alloys. The scale of this investigation, which is of interest to the electrical as well as to the engineering industries, will depend on the amount of support received from firms making use of die-casting in some form. It is proposed to undertake work in three sections, dealing respectively with aluminium alloys, brass and bronze alloys, and alloys of low melting-point, the laboratories selected being the National Physical Laboratory, the Research Department of Woolwich, and the University of Sheffield. A new feature of the Bulletin is an article by Prof. Courtman on recrystallisation, with a bibliography of 73 items. Such summaries of published work are likely to prove valuable to members. Abstracts of important papers are also included, but in view of the extensive abstracting of the Institute of Metals it is intended to confine this part of the work to a small number of papers of special technical importance. The Association has adopted a very liberal policy in regard to publication.

Modern Wireless is a new magazine which promises to play an important part in popularising the art of radio communication, and guiding the development of methods of broadcasting. The first number, which was published in February, begins an interesting series of articles by Sir Oliver Lodge describing the method of transmission of wireless waves. There is also an important article by P. R. Coursey describing methods of receiving radio signals from electric lighting wires. It is not generally known that in many cases an aerial is an unnecessary adjunct to a broadcast receiving set. All that is necessary is to connect the set through a plug and a small condenser to any electric light fitting indoors. If a gas pipe or a water pipe is available we can use it for the earth, but in many cases, as Mr. Coursey points out, even this is not necessary. All that is required is to have access to the electric lighting wires whether the supply be direct or alternating. As an aerial is objectionable for several reasons, this method will help to popularise broadcasting, but it will make it difficult for the Post Office to enforce the purchase of a broadcasting license. There are many other interesting articles in this number. We congratulate the editor, Mr. J. Scott-Taggart, who is a well-known radio expert, on his success in making this issue interesting and easily understood, and yet maintaining high technical accuracy.

The recent issue of the index parts of *Science Abstracts* completes Volume 25 of each of the sections—Physics and Electrical Engineering—for 1922. While the Electrical Engineering volume has nearly the same number of pages, 650, as last year, the Physics volume has increased by 90 pages, and now has nearly 1000 pages. The number of abstracts has increased by about 50 in the former and about 460 in the latter section, and there is a slight reduction in the average length, 0.486 page, of an abstract in the former and a considerable reduction, from 0.398 to 0.364 page, in the latter section. Ten years ago the figure was 0.317 page, and it is extremely doubtful whether the intrinsic value of scientific papers has increased in the interval to a sufficient extent to justify the increased length of the average abstract. Whatever opinion may be held on this question, there can be no doubt that *Science Abstracts* fulfils with conspicuous success its task of placing before its readers a short account of the advances made during the year in the subjects with which it deals, and that as a result it should receive every support from electrical engineers and physicists.

Research Items.

MENTAL AND PHYSICAL CHARACTERS IN RACE STUDY.—In the February issue of *Discovery*, Prof. H. J. Fleure discusses the influence of racial on mental characters. This region is, as he remarks, still uncharted by science, and the discussion is difficult because the material still remains to be collected. But racial peculiarities are strangely persistent, as, for example, in Wales, where the predominant type is in all probability due to descent, with modification, from the early Neolithic inhabitants, though it has been modified by emigration. At any rate, he rightly protests against the too common habit of treating mental characters, be it of French, Germans, or Britons, in the mass. "In each national group are many racial mosaics, and similar groups of characters occur in all. There are differences of social expression and lack of expression connected with social and historical facts, and these are apt to vary from century to century." But behind all these there are correlations of physical characters with psychical characters which at present we are unable to correlate scientifically.

THE FUTURE OF ARCHITECTURE.—In a recent issue of the *Sociological Review* (vol. xv. No. 1), Mr. S. C. Ramsey discusses the regional and vocational influences of architecture. The finest and most consistent architecture the world has ever seen was, he says, that of the ancient Greek quarryman. We can scarcely follow the writer in supporting the position that the sailor has been "the energiser and inspirer" of our buildings, nor in the assertion that "Victorian civilisation was essentially a miner's civilisation, the improvisation of the mining camp, and Victorian building was mainly of the camp or settlement variety, temporary and muddled, without real tradition, permanence, or ordered beauty." He sees hope in the houses erected under the Ministry of Health, where "mounting prices and the need for rigid economy have lopped off the extraneous and hideous features beloved of the Speculative Builder." He looks forward to the time when the person who expresses his individual pride in the building of a luxurious private house will not exactly be shunned, "but looked on a little critically," and "energy will be lavished on public buildings for the enjoyment and benefit of the community as a whole." It may be some time before this stage is reached, but meanwhile the writer's view of the position cannot safely be ignored.

CRIME AND POISONING.—Lt.-Col. J. A. Black, Chemical Examiner for the Punjab, has issued a report on the work of his department (Lahore: *Civil and Military Gazette* Press, 1921). The greater part of the report deals with matters involving the investigation of crime and especially of poisoning. Instead of expert witnesses being examined and cross-examined in a trial for poisoning as in England, the evidence of the Chemical Examiner is taken in Indian Courts, frequently in the form of a written statement. His report, therefore, contains a categorical account of the results of his analysis without indulging in probabilities or opinions, and leaving deductions, unless these are obvious, to the interpretation of the civil surgeon, whose duty it is to guide the Court. The Court does not appear to be otherwise guided in respect of matters purely chemical. The volume of work in connexion with cases of poisoning is considerable in the East, where homicidal poisoning is very prevalent, and suicidal poisoning, often from motives which appear perfectly inadequate to the Western mind, is very common. The difficulties are increased by the fact that cases of serious illness, and even of death, frequently occur without the attendance of qualified medical men, and the replies made by the police on the prescribed forms are frequently of little value. Col. Black enlivens his report by the narration of several picturesque cases which have come under his notice. The task is rendered somewhat easier by reason of the fact that the poisons available are mostly well-known, and on account of ignorance of the fatal dose, a large excess is usually administered, so helping to simplify the work of the chemist. For some of the poisons, when no chemical test is available, the microscopic appearance of the plant used is frequently quite diagnostic. Simple physiological tests are frequently made, and facilities have been afforded by setting up in Calcutta a laboratory for applying serological tests for the whole of India. Col. Black is of the opinion that no very subtle form of poisoning exists in India.

CHAPARRAL SCRUB IN CALIFORNIA.—The broad sclerophyll vegetation of California forms the subject of a communication by W. S. Cooper (Carn. Inst. Wash. Pub., No. 319) in which the ecological relationships of these types of vegetation are treated in some detail. The author is able to justify and develop the point of view of Schimper, that these types of vegetation, like the Mediterranean "maqui," develop in regions of winter rains and long dry summers. Thus the annual cycle of the "chaparral" scrub in California includes a summer period of four months in which the soil contains practically no available water, while the winter rains coincide with low temperatures. The growing period is thus limited chiefly to short periods in spring and autumn. Two main types of vegetation are compared in detail, the broad sclerophyll forest and the "chaparral," and it is shown that the habitat of the latter differs mainly in its more extreme water relations. Anatomical details of the plants in relation to habitat are well treated, a curious feature being the presence of mycorhiza in the roots of the dominant chaparral species, although the soils only average 0·1-0·3 per cent. of humus.

MITES AND ROTIFERS FROM SPITSBERGEN.—The Journal of the Quekett Microscopical Club, November 1922, contains an account by Mr. Julian Huxley of the Oxford University Expedition to Spitsbergen in 1921, followed by two reports on the collections of mites and rotifers. The aim of this expedition was primarily the study of Arctic life from an ecological standpoint rather than the search for new species, and the results promise to be of great general interest, especially from a biological point of view. Many new forms have, however, been discovered in addition to numerous new records for Spitsbergen, and as the work proceeds the number will be considerably increased. In the report on the mites, Mr. Soar describes and figures a species of Hydracarina, *Sperchon linearis* Sig Thor, taken in large numbers at Bear Island, hitherto known only from the high mountain districts of Norway and Sweden. He suggests that its appearance in Spitsbergen may be due to the agency of birds; the ova of the mites, which are deposited on stones, being probably conveyed there on the feet of birds. Mr. Bryce in his report makes similar suggestions for the occurrence of the rotifers—the agency of birds or transport by winds. He gives a valuable summary and revision of all the Rotifera found up to the present in Spitsbergen. The total number of species is now 81, of which 70 are actually more or less common in Great Britain. Twenty-eight species were taken by the expedition, of which ten are new records, one being also new to science, but even this species shows no striking variation from already known European varieties. A list is given of mosses identified by Mr. H. N. Dixon, with their localities and details of the rotifers and tardigrades they harboured. The new species of rotifer and a new parasite are described and figured.

FUMAROLES IN ALASKA.—A volcanic eruption on a great scale in June 1912 smothered in half a foot of ashes the town of Kodiak in southern Alaska. This was traced to the Katmai volcano about 100 miles to the west in the long Aleutian chain of volcanoes. In 1915 the U.S. National Geographic Society sent a preliminary expedition to examine the region. The next year a larger expedition discovered to the west of Mount Katmai the remarkable valley of the Ten Thousand Smokes which was explored in 1917, 1918, and especially 1919. These explorations were conducted by Dr. R. F. Griggs, who describes them in "The Valley of Ten Thousand Smokes" (National Geographic Society, Washington). The valley, which has an area of about 30 to 40 square miles, is floored with Jurassic sandstones and shales overlain in places by volcanic rocks. Lines of fumaroles skirt the sides and cross the valley to the number of 10,000 or more. The fumaroles generally have a temperature of 200° C. to 300° C., but some records of over 500° C. are given. Analyses of the gases showed steam to be the principal constituent, but appreciable quantities of hydrofluoric acid were present. From earlier accounts of the district it is clear that these volcanic manifestations in the valley date from the eruption of Katmai in 1912. The text is admirably illustrated by photographs, maps, and coloured plates, and gives a full account of the valley and the work of the expeditions. It is written in a popular vein but embodies a great deal of scientific interest. The study of the vegetation in relation to the ash deposits is of particular value. The valley with Mount Katmai and the surrounding country, to the extent of 1700 square miles, has been declared by the United States Government a "National Monument" reserved from settlement or exploitation.

BACTERIA AND TRAVERTINE.—An interesting case of the promotion of rapid deposition of travertine by bacterial action has been described at some length by Mr. John Parry in a lecture given before the Diamond Fields Mining Institute at Kimberley, S. Africa (Report in *Chemical News*, vol. 125, pp. 225, 241, and 257, 1922). The organisms, which are compared in their action with Drew's marine *Bacillus calcis*, occur in water streaming down the shafts of Kimberley mines, and they produce deposits of fibrous calcium carbonate in iron pipes and crusts on planks and tunnel-floors. These deposits have a lustrous black surface, which is attributed to organic matter derived from decaying timber in the mines. Evaporation clearly plays no part in the accumulation.

THE UPPER AIR IN INDIA.—A presidential address by Mr. J. H. Field to the section of physics and mathematics of the eighth Indian Science Congress on "The upper air: objects and methods of research in India," is printed in the Proceedings of the Asiatic Society of Bengal, vol. xvii., 1921, No. 4. The subject of the address was chosen as the science of meteorology has during recent years attracted to its side physicists and mathematicians of eminence who are rapidly evolving order out of chaos. In contrast to the temperature changes experienced at the ground by day and night during summer and winter, it was pointed out that at the height of half a kilometre (1640 ft.) India enjoys an equable temperature throughout the twenty-four hours. Similarly with wind, both in direction and force, great changes very commonly occur within the lowest layer. Passing upwards through a range of many kilometres, the temperature, which has been falling more or less steadily to very low values, shows a sharp halt in its rate of fall, or the "lapse-rate" suddenly becomes zero. This startling change occurs in India at a height of about 10 kilometres; near the equator it lies at about 17 kilometres, and from the equator it falls continuously with increasing latitude toward the poles, where it seems to lie at a height of about 7 kilometres. Reference is made to observations of the upper air carried out in India by means of free-flying balloons and the theodolite and by means of balloons and kites carrying self-recording meteorological instruments; many clever devices have been introduced to adapt the observations to Indian climate. The solution of rainfall problems in India is alluded to as a matter of life and death, controlling as it does the dread spectre of famine. It is the business of the Indian meteorologist to forecast with all possible speed the rains both in the monsoon and in the cold weather.

THE GREEN RAY.—Instructor Lieut.-Commr. F. W. Shurlock, R.N., of H.M.S. *Royal Sovereign*, sends the following notes describing observations of the green ray: At Vigo, on January 21 and 22, the sun set behind an island. On January 21 one tip of the disappearing segment showed the green tint, while the other was indistinct, probably owing to irregular refraction. On January 23 the disc was red and changed to magenta. At sea, off Oporto on January 24, the two tips were green. The green portion broke up into irregular patches with colours resembling those of soap films. Just after sunset a row of irregular yellow patches appeared over the place where the sun's rim was last seen. At sea, off Cape St. Vincent on January 25, the sky being clear and the sun a golden yellow, a typical example was observed. The green colour started from the tips and flooded the exposed part of the disc. After sunset, a small diffuse patch of pale green appeared immediately above the place where the sun set and faded almost at once. The whole effect lasted about three seconds and was seen by a group of trustworthy observers. It is interesting to note that with a telescope (×30) the green afterglow was distinctly seen; with binoculars (×6) it was faintly seen; while unaided observers failed to detect it.

AN IMPROVED HYGROSCOPE.—Messrs. Negretti and Zambra have devised an improved hygroscope which indicates at a glance the percentage of moisture in the air. The hair hygrometer was originally constructed by Saussure, who used a hair to indicate changes of moisture, the hair elongating when moist and contracting when dry. Considerable improvements have been made by Messrs. Negretti and Zambra, and twelve or more hairs form the basis of the new instrument; human hair is specially selected and scientifically treated. The hairs are anchored by their lower ends and the upper ends are connected to a link which operates on a lever attached to the pointer spindle. The dial is graduated from 10 to 100 in percentage relative humidity. Readjustment of the instrument, if required, is quite simple. On the lower part of the dial is a scale to ascertain the dew-point if required. It is claimed that the instrument will be of especial value in many industrial processes, and various types are manufactured depending on the requisite conditions. A large type of the same instrument combined with a dew-point hygrometer has also been devised.

Comparative Embryology of Plants.[1]

IT is generally acknowledged that land-living plants have sprung from some algal source: that the land was invaded and that the invaders show form and structure adapted to sub-aerial life. If this be true, land-plants should still show features indicating their origin, and such characters should be expected to appear in their embryology. The higher algal structure is generally referable to the filament or row of cells with a free apex, and a base attached to the substratum. The individual commonly springs from such a source, amplified in various ways to form the adult. It is found that the comparative embryology of land-plants up to the seed plants themselves also suggest a filamentous origin. The apex is defined by the very first segmentation of the zygote: the base in bryophytes is the base of the sporogonium: in leafy plants it is the suspensor, recognised by Lang as a vestigial organ. He held that its presence is a last indication of the filamentous structure, a juvenile stage rapidly passed over in them, and often suppressed. The body thus visualised between apex and base may be called the primitive spindle.

Two distinct types of its orientation exist. In the first, the apex is directed to the neck of the archegonium (exoscopic). That is the characteristic of all bryophytes, and of Equisetum, Isoetes, and Tmesipteris. In the other, the apex is directed away from the neck (endoscopic), and it is found in lycopods, some primitive ferns, and in all seed-plants. An intermediate position is seen in certain ferns, including all the later types. In fact, with some exceptions, the distinction follows the major lines of affinity in the vegetable kingdom: therefore it is probably of high morphological importance. The interest will centre round the exceptions: and their explanation is probably to be found in the varying orientation of the archegonium.

The end of all higher embryology is the establishment of a leafy plant with its shoot pointed upwards. Where the archegonium points downwards, endoscopic orientation will lead directly to this result, but if the archegonium be inclined or inverted, the spindle will have to be inconveniently curved to secure that end. Many lycopods, selaginellas, and some ferns show awkward curvatures of the embryo to carry it out. But some of them have no suspensor: in these the awkward curves are absent. It is suggested that the inconvenience has been removed by abortion of the vestigial suspensor, which tied their ancestors down to the endoscopic orientation so inconvenient where the archegonium points obliquely, or actually upwards. The horsetails, Isoetes, and the leptosporangiate ferns would all be derivative in this respect. Having no suspensors, their initial polarity could be freely determined so that the apex would point from the first in the convenient direction.

Upon the spindle thus defined, whether complete or abbreviated by abortion, straight or curved, the appendages are attached. The leaves are possibly in phyletic origin, the results of distal dichotomy of the apex. But in fact they are attached laterally, and together with the axis they constitute the terminal bud. The first root is always of lateral origin in pteridophytes, and phyletically it is an accessory organ, absent in fact in the most primitive types. It is only in seed-plants that it appears to continue the axis downwards. Lastly, the "foot," which is so inconstant in its development, is clearly accessory also, in fact a sucker formed laterally where it is required. So the primitive spindle, defined by the apex of the shoot and with the tip of the suspensor as its base, appears to be a real and constant feature in the embryos of plants. But as it is liable to be abbreviated by the abortion of its base, and complicated at the apex and also lower down by the formation of lateral appendages of various sorts, it is often effectively disguised. Nevertheless, an adequate morphological and biological comparison of plants suggests that all their embryos are referable in origin to a filamentous source, such as is prefigured in the algæ.

[1] Abstract of the presidential address to the Royal Society of Edinburgh, delivered by Prof. F. O. Bower, F.R.S., on October 23, entitled "The Primitive Spindle as a Fundamental Feature in the Embryology of Plants" (Proc. Roy. Soc. Edin., vol. xliii. part i. p. 1).

Exploitation of South African Fisheries.[1]

By Prof. J. STANLEY GARDINER, F.R.S.

THE Union of South Africa has consistently endeavoured to pursue a far-sighted policy in reference to the exploitation of its seas. A survey with the S.S. *Pieter Faure* was made twenty years ago and resulted in the starting of a trawler industry, while a series of volumes were published dealing with the fauna of the grounds. In 1920 the Union hired a whaler, the *Pickle*, 102 feet long, 20 feet beam, and 11½ feet draught, equipped the vessel with trawls, warps, and sounding gear, and sent it to explore the fishing area, Dr. Gilchrist being the scientific adviser. The ship was commissioned for 20 months. It was singularly unsuited in many respects for trawling in commercial fashion, being of too shallow draught and not of the right build, only hauling an otter trawl of 40 feet head rope, whereas a trawler of its size could employ one of 120 feet with resulting catch at least six times as great. Notwithstanding these drawbacks excellent work was done, 543 stations having been investigated, generally by 1-hour trawls, distance traversed 4 miles. While the hauls are thus closely comparable, they are difficult to collate with commercial fishing. They deal entirely with unexplored grounds; we should have liked a few on the known grounds, already frequented by steam trawlers, for comparison.

Commercial trawling is now carried on down to 300 fathoms, and the total area within these depths off South Africa is about 120,000 square miles. The grounds may be divided into three areas—the eastern off the shores from Kosi River to Port Elizabeth, 625 miles; the southern from the latter to the Cape, 360 miles; and the western from the Cape to Cunina River, 1080 miles. The eastern is mostly a 10-mile belt, sloping off steeply from 60 fathoms; this is the region of the Agulhas Current, which causes in most places a roughness unsuited to trawling. The southern is that of the Agulhas Bank, a name given to the southern broad point of the continental slopes, its edge 150 miles from the shore. The western has a broad slope, not bounded by any marked steep, about 60 miles across, half within the 100-fathom line; it is on the whole smooth and regular ground, and lying on the colder side of the Cape—average difference 10° F.—should prove good trawling ground with fish of similar quality to those of our own shores.

The two most important deeper water fish proved to be the stockfish, or Cape hake, and Macrurus,

[1] Union of South Africa: Fisheries and Marine Biological Survey. Reports Nos. 1 and 2 for the years 1920 and 1921. By Dr. J. D. F. Gilchrist.

or Cape whiting, both of which have their centres of intensity at 150 fathoms, or even deeper. There is also the kingklip (in appearance like a ling), the dogfish, various soles and other flatfish, but the variety of economically valuable trawl fish so far obtained is not great. New fishing areas were discovered off Durban and off the Umvoti River, but neither of these are of sufficient size for steam trawlers. However, crayfish up to 12 inches occurred in immense numbers, a commercial trawler subsequently, in a haul of 1½ hours, taking more than 10,000. The results of the investigation indicate an abundance of life on all this eastern ground, and it must carry its due proportion of fish. Many small areas suitable for trawling appear likely to be disclosed by further survey, but it is not an area for steam trawlers, though, like the west coast of France, it should develop in time a considerable population of "longshore" men.

Turning to the south and west the reports give indications here of the possible development of an immense fishery. The *Pickle* demonstrated to the local trawlers the potentialities of deep-sea fishing, and new areas were found within a few hours' steaming of Cape Town. The most northerly trawlings were off Luderitz Bay, and it would seem probable that there is good ground right down to Cape Town; we should also expect similar ground further north as far as Union territory extends. Before such ground can be exploited commercially it must be surveyed, so that trawlers may avoid rough patches. To know the depth and nature of the bottom is not enough, and trawling tests are essential. Doubtless the fish migrate at different seasons, so that the latter tests will have to be undertaken at least twice over. It is an expensive business, of course—the running expenses of a trawler would be about 1000*l.* per month—but the encouragement of food production is a vital necessity to all States, while fish-meal is a bye-product of high value. In any event it is clear that South Africa has to the south and west an area more than capable of supplying all the fish that can at present be consumed; the western grounds alone may well prove as rich as those to the south of Ireland of about the same area, which in 1910 produced 1·35 million cwts.

With these potentialities in mind it is extraordinary to find that the fishery vessel is to be given up. In substitution a survey vessel, *Crozier*, is to be used at intervals for fisheries work. To employ a twin-screw vessel with a complement of 80 hands for such work is wretched economy, work which can be better done with a trawler and a crew of 14. The phase of using such Admiralty vessels for fishery work is one which nearly every country of Western Europe has passed through and abandoned; surely South Africa would be well advised to learn by their experiences. In any event we trust that the series of special reports on the fauna obtained by the *Pickle*, commenced in report 2, will be proceeded with; they are of high scientific value.

The Teaching of Elementary Geometry.[1]

The Assistant Masters' Association recently appointed a committee to consider the teaching of elementary geometry; the report of this committee, backed by the authority of the Executive Committee of the Association itself, that of the Assistant Mistresses' Association, and that of the Educational Institute of Scotland, has now been published. The outstanding fact, and one of no little importance, is that the committee was appointed to produce an agreed sequence of propositions and has not done so. The terms of reference were:

(*a*) To examine the case for an agreed sequence;
(*b*) To suggest the best means of attaining the general adoption of the sequence agreed upon.

The most definite conclusions are:

VII. The committee does not feel that it is either desirable or possible at present to stereotype a sequence; and

I. No formal proofs should be required of Euclid I. 13, 14, 15, 4, 8, 26, 27, 28, 29. . . . The teaching of formal geometry should be based upon the quasi-axiomatic acceptance of these results.

The committee is unquestionably right in its belief "that the main difficulties due to variety of sequence will be removed if the first of its recommendations [*i.e.* I. just quoted] is generally accepted," and possibly the most valuable feature of the report is the extended currency it will give to this principle.

For the rest, the committee is concerned not so much with principles as with giving what help it can to the "very large number of teachers who do not claim to be experts in geometry" and who need "guidance amid the welter of sequences and methods . . . published during the last twenty years." From this modest and reasonable point of view little fault will be found with the detailed recommendations, though, as is freely admitted, there is room for difference of opinion on many points. A teacher who followed their scheme exactly would come to no harm.

The committee follows in the main the "Cambridge Schedule," with some expansions (which some will not think improvements) apparently designed to show exactly how it intends the propositions to be dealt with. For example, the section on areas begins with the rule for measuring the area of a rectangle and the section is more detailed than in the Schedule, clearly indicating a treatment different from Euclid's. It is pointed out at the end of Section VI. that Pythagoras's proposition and Euclid III. 35, 36 should be dealt with by the use of similarity as well as by Euclid's method. The report contains a needed warning (Recommendation IV.) against the slovenly use of the "method of limits" in dealing with tangency; and another (Recommendation V.) against ignoring the existence of incommensurables; "at the proper stage," the committee says, "the attention of the pupil should be called to the fact that the proofs given do not cover all cases."

A very important feature of the report is that certain propositions are marked with an asterisk, indicating that formal proofs of them should not be required in examinations. Some are marked also with a (†), indicating that no formal proof should be attempted in the class-room.

On this point the practice of Examining Bodies differs; most of them asterisk propositions, but some more, some less. It would undoubtedly be of great assistance to the schools if uniformity could be reached, and for this purpose the selection made by the committee might well be taken as the standard.

Altogether, the committee may be congratulated on its work; it has not set up obstacles to further progress, as with its terms of reference it easily might have done; on the other hand, the report will probably reach many teachers who need help and will give them much of the assistance they need.

[1] The Teaching of Elementary Geometry: Being the Report of a Special Committee appointed by the Incorporated Association of Assistant Masters in Secondary Schools. Pp. 15. (London: Oxford University Press, 1923.) 1s. net.

Photograph of a Bright Meteor.

CONSIDERING the great frequency of the appearance of bright meteors which flash across the night sky, it is astonishing how few photographs of them have been obtained. The actual photographing of a meteor is really quite a simple matter, but the whole success of the operation depends on whether the camera is pointed to the position in the sky where a meteor happens to pass.

FIG. 1.—Photograph of a Taurid fire-ball.

While any camera will serve the purpose, a suitable instrument is one having a large aperture and short focal length. In a communication to the Royal Astronomical Society (Monthly Notices, vol. 83, p. 92) Dr. W. J. S. Lockyer describes a very interesting photograph which he has secured, and also the instrument used. The lens is an old portrait doublet having an aperture of five and a quarter inches and a focal length of twenty-eight inches; quite a suitable lens. This lens is mounted in a home-made box camera which carries a plate $8\frac{1}{2} \times 6\frac{1}{2}$ in. The field of the lens covers about 16 degrees.

For the purpose of photographing meteor trails, the camera is fixed firmly on a stand and pointed directly at the pole star. This direction is chosen because the stars make their trails completely on the photographic plate, these trails being portions of small circles. By comparing such trails with a star atlas all the stars can be easily identified and the position of the meteor trail accurately deduced. It is Dr. Lockyer's usual practice, when working at night with the 9-inch prismatic camera of the Norman Lockyer Observatory, always to expose as long as possible one plate in this meteor camera, which is erected just outside the dome.

During the night of November 16 last, the plate (Marion's "Record," H.D. 500) was exposed from $8^h\ 58^m$ to $11^h\ 12^m$ G.M.T. In the course of development the first images to appear were the trail of the pole star and a long streak across the plate which was the trail of a bright meteor. A reproduction of a portion of this plate (reduced by one-quarter) is shown in Fig. 1. The photograph shows practically the complete length of the meteor trail.

Considering the slowness of the movement of the image of the pole star (the short brightest trail near the pole) due to the earth's rotation, and the relatively great speed of the meteor—probably in any portion of its trail only a very small fraction of a second—the brilliancy of the latter must have been very great, judging by the great density of the trail.

The most striking feature of the meteor's trail is the great differences in intensity along its path. In some portions it is so bright that it has produced halation on the photographic plate (unbacked) as strong, if not stronger, than the pole star itself. These intensity differences are due most probably to the unequal volatilisation of the material forming the meteor.

It is interesting to note that the meteor trail, when traced on a celestial globe, passes close to a star named κ Tauri, the radiant point, for that date, of slow-moving bright meteors, as determined by Mr. W. F. Denning. Evidently the meteor here photographed was a Taurid fire-ball and the brilliancy of its image was due to its comparatively slow motion.

An Australasian Biological Collecting Expedition.

THE native animals and plants of Australia are of exceptional interest, and many of them are likely to disappear, or at least to become rare, as the result of the extension of the settled areas of the country—a process which has already been in operation for many years. The Trustees of the British Museum, recognising the importance of securing an adequate representation of this remarkable fauna and flora while there is yet time, have made arrangements for a collecting expedition, which started from London a few days ago. Mr. G. H. Wilkins, to whom the leadership has been entrusted, has special qualifications for carrying out his task with success. He is Australian by birth, and he has a good knowledge of the country, where he has many friends from whom he may expect to receive valuable assistance. He has travelled extensively in various parts of the world, and he has already acted as naturalist to several important expeditions. He spent four years, 1913–1917, on the coast of Alaska and in the Beaufort Sea, as a member of the Stefánsson Canadian Arctic Expedition. In 1920 he visited Graham Land with the Cope Expedition, and in 1921–22 he was with the Shackleton-Rowett Expedition, in the *Quest*, visiting South Georgia and the Antarctic Quadrant from Enderby Land to Coats Land. On the return journey valuable collections were made at Gough Island.

Mr. Wilkins expects to be able to obtain assistance, partly voluntary, in Australia, and thus to be provided with a scientific staff among whom the various branches of the work will be distributed. A special effort will be made to obtain good series of mammals, birds, insects, and other members of the land fauna, and to spare some time for the collection of plants. He will collect first in Queensland, at one or two selected stations, going south when the rainy season commences, revisiting Queensland in 1924, and reaching the Cape York Peninsula in one or both years.

A preliminary survey, on a smaller scale, by a collector employed by the Godman Exploration Fund Trustees, has shown that the representation of Australian mammals in the national collection is by no means so complete as it should be; and there is good reason to believe that the projected expedition will add considerably to existing knowledge. This preliminary work has been rendered possible by a generous gift made by Dame Alice Godman and her daughters, in memory of the late Mr. F. du Cane Godman, a trustee of the British Museum. The fund thus created will enable the Museum to do much useful work of a similar character, and its utility would be greatly increased if it were to be augmented by the contributions of other benefactors. It is not sufficiently realised that the work of the Museum is hampered in many directions by the want of funds which would perhaps be supplied from private sources if its needs were more generally known.

University and Educational Intelligence.

ABERDEEN.—Mr. W. W. M'Clelland, additional lecturer on education, has been appointed principal lecturer on education in the Edinburgh Training Centre.

The statutory meeting of the council of the Association of University Teachers of Scotland was held in Aberdeen on Saturday, February 10. Prof. F. O. Bower was appointed chairman of the council for the ensuing year, and Dr. W. W. Taylor, honorary secretary.

BRISTOL.—The following appointments have been made at the Agricultural and Horticultural Station at Long Ashton: Mr. H. Briton-Jones, as lecturer in mycology; Mr. Edward Ballard, as adviser in plant pathology, and Mr. H. P. Hutchinson, as organiser of research in willow growing.

Arrangements are being made for holding a summer school on August 3-17. Prof. Lloyd Morgan will again be president of the school, and Mr. W. W. Jervis will act as director of studies.

Geography will, in future, be included as a subject for the final part of the curriculum for the degree of B.Sc.

CAMBRIDGE.—Mr. G. E. Briggs, St. John's College, has been re-appointed demonstrator in plant physiology.

A further report of the Syndicate appointed to draft Ordinances to carry out the new statute for the admission of women to degrees has just been issued. In one very important point the report has now been modified; the women students are to be given the right to admission to University instruction effectively on the same terms as members of the University. It looks as though one chapter in this long-standing controversy is drawing to a close.

Revised regulations for the medical examination have been submitted to the Senate for approval. The transference of organic chemistry from the First M.B. examination to the Second M.B. examination will facilitate the process by which the First M.B. examination is passing from the University to the schools.

EDINBURGH.—The University Court has accepted with much gratitude a gift by Mr. James A. Hood, of Midfield, Lasswade, of the sum of 15,000*l.* to endow a chair of mining. It is proposed that the chair should be established by the University and the Heriot-Watt College in co-operation.

The following appointments have been made: in the faculty of science, Dr. Malcolm Wilson to be reader in mycology and bacteriology, and Dr. H. Robinson reader in experimental physics; in the faculty of arts, Dr. G. A. Carse to be reader in natural philosophy.

The Cameron prize in the faculty of medicine, which is given annually in recognition of some important and valuable addition to practical therapeutics, has been awarded for 1923 to Prof. J. J. R. Macleod, of the University of Toronto.

LONDON.—A course of three free public lectures on "Recent Work on Inborn Errors of Metabolism" will be given by Sir Archibald E. Garrod, in the Robert Barnes Hall of the Royal Society of Medicine, at 5.30, on Wednesdays, February 28, March 7 and 14.

OXFORD. On February 13, Congregation had before it a proposal to establish a new final school in science and philosophy. The scheme was introduced by Prof. C. J. Webb and Mr. H. B. Hartley, and supported by Profs. H. H. Joachim and J. L. Myers. It was opposed by the Warden of Wadham and Mr. H. W. B. Joseph, and thrown out on a division by 66 to 38. Many will regret that an opportunity for bringing scientific and philosophical studies into closer relation has thus been lost. The arguments of the opposition that carried most weight were probably those that were concerned with matters of practical difficulty rather than of principle.

The reports of the Delegates for Forestry and of the Committee for Rural Economy were presented to Convocation on February 20. The former report gives the number of students at the beginning of the year as 76. Lectures were delivered on silviculture, general and tropical, forest management, mensuration, protection, policy, valuation, utilisation, botany, entomology, surveying, and engineering, by Prof. Troup, Sir William Schlich, and others. Parties of students were taken for practical instruction to France, Austria, and various stations in England. Full use was made of the practical training ground of Bagley Wood. The first of the Oxford Forestry Memoirs was issued during the year.

The Committee for Rural Economy reports the number of students of agriculture as 134. Lectures have been given by Prof. Somerville and others. The University farm has been largely used for practical demonstrations, and other farms have been visited and important papers have been published. A special study of farm management has been conducted under the auspices of the Institute for Research in Agricultural Economics. A research on soils is in progress by Mr. G. R. Clarke.

Both of these departments show evidence of great activity and efficiency. They have come to take an important part in the present life of the University.

AN engineering scholarship, of the annual value of 70*l.*, tenable for three years, provided by the South Wales Institute of Engineers, is being offered for competition by the University College of South Wales and Monmouthshire. Further information, and the form of application, may be obtained from the Registrar, University College, Cardiff. Applications must be received by, at latest, March 19.

THE annual general meeting of the Association of Technical Institutions will be held at the Carpenters' Hall, Throgmorton Avenue, London, E.C., on Friday and Saturday, March 2 and 3. At the opening meeting the president, the Right Hon. Walter Runciman, will introduce the president-elect, Sir Alfred Herbert, who will deliver his presidential address. The following papers will be read on the Friday afternoon and Saturday morning: "Modern Systems of Apprenticeship and Training of Young Workmen with reference to Technical Education," Mr. W. Calderwood; "The Guilds of London and Technical Education," Mr. C. C. Hawkins; "The British Colour Industry—its Dependence on the Place of Research in the Scheme of Higher Education," Dr. H. H. Hodgson; "The Dyeing Industry, Research Work and Technical Education," Dr. Levinstein.

Societies and Academies.

LONDON.

Royal Society, February 15.—E. R. **Speyer**: Researches upon the Larch Chermes (*Cnaphalodes strobilobius*, Kalt.), and their bearing upon the evolution of the Chermesinæ in general. Alternation of form is the normal course of biological development in all Chermesinæ, but it breaks down in *Cnaphalopes strobilobius*, Kalt. The Progrediens type of all Chermesinæ is potentially a winged form, and is not a true dimorphism of the Sistens type. The Sexuales are different morphologically from all other generations and are probably a new production in evolution. Species which are purely parthenogenetic have ceased to develop from an evolutionary point of view, and show the probable course of evolution in the various genera. Migration from one species of conifer to another is responsible for a duplication in the series of form-alternating, parthenogenetic generations; the series upon one conifer has become morphologically different from that on the other through the action of Natural Selection in two different environments. In existing species with two host-plants, that portion of the cycle which now takes place upon the definitive host-plant has arisen through a stimulus given by a recent return to sexuality, this accounting for the linking up of the two cycles and a duplication of the series of parthenogenetic generations.—G. V. **Anrep**: The irradiation of conditioned reflexes. Experiments were performed with tactile conditioned reflexes, the parotid gland being taken as the effector organ. The tactile reflexes established on one side of the animal irradiate without a measurable decrement into the other side of the animal. The conditioned inhibition is in broad limits a cruder form of inhibition than the differential inhibition. The irradiation of the conditioned inhibition follows in the main the rules established for the irradiation of the differential inhibition and that of the reflex itself. The short trace reflexes take an intermediate position between the simultaneous and the long trace reflexes.—M. **Dixon** and H. E. **Tunnicliffe**: The oxidation of reduced glutathione and other sulphydryl compounds. The reduction of methylene blue by the sulphydryl compounds, reduced glutathione, cystein, and thioglycollic acid, is an autocatalytic reaction. The active agent producing this catalysis is the disulphide form R . S . S . R. The disulphide compounds also catalyse the oxidation of the sulphydryl compounds by atmospheric oxygen. The form of the reaction curves is not autocatalytic. The reaction velocity in the cases of glutathione and cystein shows a sharp optimum at a pH of 7·4. Thioglycollic acid does not show this. The bearing of these results on the conception of the function of glutathione and related compounds in tissue oxidation processes is discussed.—J. C. **Bramwell**, R. J. S. **McDowall**, and B. A. **McSwiney**: The variation of arterial elasticity with blood pressure in man. A method is described by which the extensibility of an artery in living man may be measured at all internal pressures up to the diastolic pressure. As in the case of an isolated artery, the extensibility decreases as the internal pressure is increased.—L. J. **Harris**: On the existence of an unidentified sulphur grouping in the protein molecule. Pt. I.—On the denaturation of proteins. Pt. II.—On the estimation of cystine in certain proteins. The conditions under which the grouping reactive to nitroprusside is liberated from ovalbumin and other proteins, and of its survival in the proteose, peptone, and polypeptide molecule, were examined. The nitroprusside reaction, attributed by Arnold to cystein, may be due to the presence of a grouping of the thiopeptide type. Gravimetric estimation of cystine in proteins by a new method indicates that whereas in serum albumen the cystine accounts for 89 per cent. of the total sulphur content, in ovalbumin 86 per cent. of the sulphur still remains to be accounted for.—N. B. **Laughton**: Reflex contractions of the cruralis muscle in the decerebrate and spinal frog. In the decerebrate frog there was a prolonged tonic after-effect in the contraction of the cruralis muscle on reflex stimulation of the ipsilateral sciatic nerve. No such tonic effect was observed in the cruralis muscle of the spinal preparation. A shorter latent period and a more rapid increment of height were marked in the spinal preparations. During spinal shock the height of the reflex contraction in the spinal frog is not maximal. In half the experiments the height of the myogram was greater in the decerebrate than in the spinal preparations.

British Mycological Society, January 20.—H. **Wormald**: Crown gall on nursery stock. Résumé of crown gall investigations and account of crown gall on apple stock in this country.—Miss W. **Ridler**: The fungus present in *Lunularia cruciata*. The fungus is not constant in occurrence, but when it occurs, it is definitely localised. There is no evidence that the fungus has any effect on the production of sexual reproductive organs or gemmæ or on the size of the plants. The association is regarded as harmless parasitism on the part of the fungus.—A. S. **Horne**: The systematic characters of closely allied strains of Fusarium were described. Spore shape, dimensions, and septations have proved exceedingly variable and of less relative value in classification than occurrence of sclerotia, chlamydospores, colouring principles, relation to active hydrogen, etc. "Sectoring" often occurs in culture and has resulted in increase in the number of strains from 6 to about 14.—W. **Brown**: Experiments on growth rate and cultural factors of the same species of Fusarium. The amount of "staling" varied in different strains. Practically any cultural characteristic can be developed in any one strain by choosing suitably the composition of the various constituents of a synthetic medium.—J. **Ramsbottom**: Berkeley and Broome: An account of the way in which these two mycologists became interested in the study of fungi and associated together, as shown by their correspondence in the British Museum (Natural History).

Geological Society, February 7.—Prof. A. C. Seward, president, in the chair.—G. Vibert **Douglas**: Geological results of the Shackleton-Rowett (*Quest*) expedition. The more detailed work commenced in South Georgia, which lies 900 miles east of Cape Horn and is 100 miles long by 20 miles in width. It is an upland dissected by glacial action. The glaciers in general show signs of withdrawal. The island consists of sedimentary rocks and, at the south-eastern end, igneous rocks. The sediments may represent two periods of deposition, divided by an unconformity. The rocks all show signs of metamorphism, and the strike of the folds and lamellæ of the phyllites indicate that the pressure came either from the south-south-west or from the north-north-east. Elephant Island is situated in the Powell group of the South Shetlands and is an ice-covered plateau rising to 1200-1500 feet above sea-level. The Tristan da Cunha Group, 1500 miles west of the Cape of Good Hope, are of volcanic origin. Gough Island, more than 200 miles south of the Tristan da Cunha Group, is 8 miles long by 3 miles in width. It is a monoclinal block, with dip-slopes to the west and escarpments to the east. The lavas forming these features are basaltic, and intrusive into these lavas is a trachytic stock. Following this intrusion the basalts were cut by a series of doleritic dykes. In general, it is similar to Ascension and St. Helena Islands.

DUBLIN.

Royal Dublin Society, January 23.—Prof. J. A. Scott in the chair.—J. **Joly**: Isostasy and continental drift.—H. H. **Dixon** and N. G. **Ball**: The structure of the vascular supply to the storage organs of some seedlings. According to the view that the tracheæ convey material only in an upward direction, and are not functional in the downward transport of organic substance in the plant, the organs connecting the stores of organic substances with embryos would either contain no tracheal (woody) strands, or would possess only vestigial traces of this tissue. In the seedlings of *Lodoicea sechellarum*, *Phœnix canariensis*, *P. dactylifera*, *P. silvestris*, and of *Vicia faba*, the petiole of the cotyledon transports the stored organic material to the growing embryo, and in the bundles the tracheal or woody strand is normally developed, and in some cases, at least, the tracheæ are differentiated earlier than the sieve-tubes. Hence the structure of these seedlings is in agreement with the view that the wood transmits organic materials.

PARIS.

Academy of Sciences, January 29.—M. Albin Haller in the chair.—Georges J. **Rémoundos**: The iteration of multiform functions.—A. **Angelesco**: A class of polynomials and an extension of Taylor's and Laurent's series.—E. **Gau**: The study of invariants relating to the characteristics of partial differential equations of the second order with two independent variables.—Birger **Meidell**: The probability of errors.—Paul **Piketty**: Cold hardening by drawing. The method of M. Seigle for increasing the strength of metal bars by extension up to the elastic limit was utilised by the author in 1911 for reducing the weight of steel in reinforced concrete construction.—Jean **Chazy**: The expression of Einstein's law in Cartesian co-ordinates.—MM. **Huguenard, Magnan**, and A. **Planiol**: A compensated hot wire anemometer. The most convenient way of mounting a hot wire anemometer is to measure the fall of potential over a resistance placed in the circuit containing the hot wire. The curve showing the gas velocity as a function of the potential differences is nearly parabolic, and as a consequence accurate measurements can be made only over a narrow field. If the shunt be replaced by a fine platinum wire of variable resistance, the conditions can be arranged to give a linear relation between the potential differences and the gas velocity.—Rodolphe **Soreau**: The laws of variation of the characteristics of standard air with altitude. A new formula is deduced for the pressure as a function of the altitude in which the temperature of the air is eliminated. The pressures calculated from the equation agree well with the experimental results, the latter being computed from 89 observations with balloons at heights ranging up to 20,000 metres.—L. **Décombe**: The theory of gravitation.—M. de **Broglie** and J. **Cabrera**: The gamma rays of the radium and thorium family studied by their photo-electric effect. The apparatus described in an earlier communication has been applied to determine the wave lengths of the gamma rays of the mesothorium group.—A. **Portevin** and P. **Chevenard**: The dilatometric study of the alloys of aluminium with magnesium and silicon. The coefficients of expansion of the alloys were obtained by a differential method against a standard of pure aluminium.—Mlle. G. **Marchal**: The dissociation of silver sulphate. The dissociation was studied over the temperature range 820° C.-1220° C., and the partial pressures of oxygen, sulphur dioxide, and sulphur trioxide calculated for 28 temperatures between these limits.—Paul **Mondain-Monval**: The law of solution. Sodium nitrate obeys the solubility law of Le Chatelier very closely.—Edouard and Remy **Urbain**: The atmolysis of a gaseous mixture containing several constituents. Application to the mixture utilised in the sulphuric acid industry by the contact method.—F. **Loewinson-Lessing**: A relation between the atomic numbers and atomic weights of the chemical elements. Starting with helium, for the first twenty elements the atomic weight is equal (within one unit) to the sum of the atomic number of the element and of that immediately succeeding it.—L. J. **Simon** and G. **Chavanne**: A new method of preparation of monochloracetic acid. The preparation is based on the hydration of trichlorethylene by sulphuric acid (90-93 per cent.) at a temperature of 170° C. The yield is more than 90 per cent. of the theoretical.—M. **Tiffeneau** and Mlle. J. **Lévy**: Pinacolic and semi-pinacolic transpositions. Comparison of the aptitude to migration of various radicals. In these transpositions the migrating tendency of the ethyl and benzyl groups is much more marked than with the methyl radical. No satisfactory explanation for this can be given.—A. **Briquet**: The invasion of the sea on the coast of Berck and the teachings of recent geology. The encroachments seriously threaten the Haut-Banc light and the City of Paris Hospital. The causes and possible engineering remedies are discussed. F. **Raspal**: Temperature measurements in trial borings 1700 metres deep near Molières (Gard). At 1674 metres depth the temperature was 82°·5 C. A rise of 1° C. per 24·3 metres was found as an average over the range 300 metres to 1674 metres.—Pierre **Bonnet**: The existence of the upper Silurian and lower Devonian in southern Transcaucasia.—G. **Pontier**: The presence of *Elephas planifrons* in the red crag (English Upper Pliocene). An account of a detailed examination of a molar of *E. planifrons* found north of Felixstowe in 1922.—J. **Thoulet**: Relation between the depth of the line of appearance of mud and the depth of the waves.—Ph. **Wehrlé** and R. **Cordebas**: The notion of phase in the study of the undulatory perturbation of pressure.—Marcel **Mirande**: Special elaborating organites (sterinoplasts) of the epidermis in the scales of the bulb of the white lily.—Robert **Stumper**: New researches on the venom of ants. Determinations of the percentages of formic acid from three species of ants (*Cataglyphis bicolor*, *Camponotus æthiops*, and *Camponotus maculatus*). Formic acid was proved to be the only free volatile acid present. E. **Aubel**: The microbial metabolism of lactic and pyruvic acids.—René **Legendre** and Maurice **Nicloux**: A mask designed for administering oxygen in artificial respiration. After poisoning by carbon monoxide or other gases, the efficiency of the usual methods of artificial respiration is much increased if oxygen is simultaneously administered. The mask described resembles those used in administering anæsthetics, and leaves the eyes uncovered. It is furnished with two valves and is of small capacity. Schafer's method of artificial respiration is recommended.—Georges **Mouriquand** and Paul **Michel**: The experimental conditions of the action of cod liver oil. Its osteodystrophic power in the presence of an insufficient food regime.

Official Publications Received.

Ministerio da Agricultura, Industria e Commercio. Annuario publicado pelo Observatorio Nacional do Rio de Janeiro, para o anno de 1923. (Anno 39.) Pp. xiv+462. (Rio de Janeiro: Imprensa Nacional.)

Ministerio da Agricultura, Industria e Commercio: Directoria de Meteorologia. Boletim Meteorologico: anno de 1911. Pp. v+94. Boletim Meteorologico: anno de 1917. Pp. 147. Boletim Meteorologico: anno de 1918. Pp. v+139. (Rio de Janeiro.)

The Carnegie Trust for the Universities of Scotland. Twenty-first Annual Report (for the Year 1921-22) submitted by the Executive Committee to the Trustees on 14th February 1923. Pp. iv+81. (Edinburgh.)

Report of the Secretary of the Smithsonian Institution for the Year ending June 30, 1922. (Publication 2709.) Pp. iii+125. (Washington: Government Printing Office.)

Věstník Kralovské České Společnosti Nauk. Třida Matematicko-Přírodovědecká. Ročník 1920. (Mémoires de la Société Royale des Sciences de Bohême. Classe des Sciences. Année 1920.) Pp. iv+17+20+21+11+20+6+43+93. (Prague: F. Řivnáč.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Vincent, for the Year 1921. Pp. iv+44. (Trinidad.) 6d.

Diary of Societies.

SATURDAY, FEBRUARY 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (2).

BRITISH PSYCHOLOGICAL SOCIETY (at Bedford College), at 3.—Prof. T. H. Pear: An Examination of some Current Beliefs concerning Muscular Skill.—Miss M. MacFarlane: The Use of Mental Tests in American Schools and Clinics.

MONDAY, FEBRUARY 26.

VICTORIA INSTITUTE, at 4.30.—Dr. A. T. Schofield: The Voices behind Spiritism.

INSTITUTE OF ACTUARIES, at 5.—P. H. McCormack: Damaged Lives and Options.

FELLOWSHIP OF MEDICINE (at Royal Society of Medicine), at 5.30.—C. Rowntree: Cancer of the Breast.

INSTITUTION OF MECHANICAL ENGINEERS (London Graduates' Section), at 7.—Prof. E. G. Coker: Photo-Elastimetric Researches on Mechanical Engineering Problems.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Adjourned Discussion on: Dental Sepsis as an Œtiological Factor in Disease of other Organs.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Lt.-Col. T. T. Behrens: The Brenner Pass Boundary and Italy's New Province.

TUESDAY, FEBRUARY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur E. Shipley: Life and its Rhythms: (1) Life and its Attributes.

BRITISH SCIENCE GUILD (at Mansion House), at 3.30.—Sir Ronald Ross, Rt. Hon. Sir Joseph Cook, and others: The Importance of promoting Efficiency and Economy in Industry, Commerce and all Imperial Affairs by the Progressive Use of Science and Scientific Method.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. W. G. Savage: Canned Foods in Relation to Health (2).

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Eng.-Comdr. R. Beeman: Auxiliary Machinery.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—R. Chislett: Bird Life in the North Isles of Shetland.

CIRCLE OF SCIENTIFIC, TECHNICAL, AND TRADE JOURNALISTS (at Institute of Journalists).—J. L. Greaves: Paper: Some developments in its Manufacture.—Discussion on the Requirements of Art, Trade, Technical and other Journals.

WEDNESDAY, FEBRUARY 28.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—S. H. Warren: The Late Glacial Stage of the Lea Valley (Third Report). With a Report on the Arctic Flora by Mrs. Eleanor Mary Reid and Miss Marjorie Elizabeth Jane Chandler.—S. H. Warren, with Appendices by Dr. C. W. Andrews, Mrs. E. M. Reid, and Miss M. E. J. Chandler, A. S. Kennard, B. B. Woodward, and M. A. C. Hinton: The *Elephas-antiquus* Bed of Clacton-on-Sea (Essex), and its Flora and Fauna.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications of the Microscope Section), at 7.—Demonstrations and Exhibits.—C. Baker: The R.M.S. Microscope (New Model).—C. Beck: Mercury Globules under Polarised Light, with Special Reference to Dr. Owen's Communication read at the last Meeting.—A. Gallenkamp and Co., Ltd.: The Gallenkamp Electrometric Titration Apparatus, an "End Point" Indicator for all Acid, Alkali and Oxidation Titrations.—Adam Hilger, Ltd.: Interference Accessory for testing the Stands and Fine Adjustments of the Microscopes—Vertical Illuminator for the Microscopical Examination of Opaque Objects.—Ogilvy and Co.: Silverman Illuminator for Opaque Objects and Standard Illuminator, both showing Similar Specimens for Comparison of Image—W. Watson and Sons, Ltd.: A Petrological Binocular Microscope for Glass Examination, illustrated by Lantern Slides.—H. J. Denham: Some Mounting Media for Microscopic Objects, especially for Cotton and other Hairs and Fibres, and for general Microscopical Work.—T. Terrell, junr.: The Use of the Microscope in the Gas Mantle Industry.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. E. S. Turner: Heat Resisting Glasses.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Medical Society of London), at 8.30.—Dr. J. A. Hadfield: Some Observations and Criticisms of Psychotherapeutic Methods.

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.—Sir William Hale-White: Pasteur in Relation to Medicine.—Prof. T. M. Lowry: Pasteur in Relation to Chemistry.—Dr. G. Monod: Pasteur as an Artist.

THURSDAY, MARCH 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—T. Stevens: Water Power of the Empire (1).

INSTITUTE OF CHEMISTRY at 4.30.—Annual General Meeting.

ROYAL SOCIETY, at 4.30.—A. Mallock: The Effect of Temperature on some of the Properties of Steel.—Prof. C. H. Lees: Inductively Coupled Low Resistance Circuits.—Lord Rayleigh: Studies of Iridescent Colour, and the Structure producing it. I. The Colours of Potassium Chlorate Crystals. II. Mother of Pearl. III. The Colours of Labrador Felspar.—Dr. L. V. King: The Complex Anisotropic Molecule in Relation to the Dispersion and Scattering of Light.

ROYAL COLLEGE OF SURGEONS OF LONDON, at 5.—Dr. W. G. Savage: Canned Foods in relation to Health (3).

LINNEAN SOCIETY OF LONDON, at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major F. M. Green: Helicopters.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Prof. L. Hill: The Sun and Open-Air School.

INSTITUTE OF ELECTRICAL ENGINEERS, at 6.—Report presented on behalf of the British Electrical Research Association by S. W. Melsom and E. Fawssett on Permissible Loading of British Standard Paper-insulated Electric Cables.

CHEMICAL SOCIETY, at 8.—N. V. Sidgwick: Co-ordination Compounds and the Bohr Atom.—W. H. Gray: Silver Salvarsan.—Prof. H. B. Dixon: On the Propagation of the Explosion-wave through Gaseous Mixtures.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—S. Forsdike: The Treatment of Hæmorrhage at the Menopause by Radium, with a report upon 45 cases.

CAMERA CLUB, at 8.15.—G. B. Clifton: My Method of making Bromoil Prints.

FRIDAY, MARCH 2.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual General Meeting) (at Carpenters' Hall), at 11 and 2.—Sir Alfred Herbert: Presidential Address.

EMPIRE FORESTRY ASSOCIATION (at Guildhall), at 3.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.—Dr. J. Horne: Tumours in the Inter-Arytenoid Space of the Larynx.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—C. T. Onions: Dictionary Evening.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—C. Saxton: Glass-forming Machines.

BRITISH MEDICAL ASSOCIATION (Marylebone Division), (at Medical Society of London), at 8.—Dean Inge: Religion and Medical Sociology.

ROYAL SOCIETY OF MEDICINE (Anæsthetics), at 8.30.—Dr. W. G. M'Cardie: General Anæsthesia in ordinary Dental Surgery (to be followed by a discussion).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. G. C. Simpson: The Water in the Atmosphere.

SATURDAY, MARCH 3.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual General Meeting) (at Carpenters' Hall), at 11 and 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (3).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—S. H. Warren: The Interplay of Land and Sea.

TUESDAY, FEBRUARY 27.

LONDON SCHOOL OF ECONOMICS, at 5.—Sir Josiah Stamp: Statistics, before, during, and after the War: Income and Wages.

WEDNESDAY, FEBRUARY 23.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. Graham Wallas: The Competition of the Sexes for Employment (Stansfeld Lecture).

KING'S COLLEGE, at 5.30.—Principal L. P. Jacks: The Limitations of Natural Science.

ROYAL SOCIETY OF MEDICINE, at 5.30.—Sir Archibald E. Garrod: Recent Work on Inborn Errors of Metabolism. (Succeeding Lectures on March 7 and 14.)

THURSDAY, MARCH 1.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 5.—Sir Ryland Adkins: Architecture and the Countryside (a Layman's Question).

UNIVERSITY COLLEGE, at 5.30.—Prof. A. E. Richardson: The Public Buildings of Sir Christopher Wren.

FRIDAY, MARCH 2.

KING'S COLLEGE, at 5.30.—C. E. M. Joad: The Case for Pluralism (1). (Succeeding Lectures on March 9 and 16.)

SATURDAY, MARCH 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Legends of the Gods of Ancient Egypt.

NATURE

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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Sequence in School Geometry.

THERE is discontent as to the condition of geometry teaching in schools, and in the search for remedies the question has been reopened whether there should be an "agreed" sequence. It appears from the report summarised in NATURE of February 24, p. 271 that 90 per cent. of those members of the Assistant Masters' Association who replied to a questionnaire voted for such a sequence, but there is the significant note, "The figures cannot be more than approximately correct, as some of the replies were difficult to interpret." It may be worth while to consider the question itself: what is meant by a "sequence"; for, unless we are clear about this, the question is ambiguous, and discussion, to say nothing about voting, may be wide of the mark.

Fifty, forty, even thirty years ago the pathway through school (and even college) mathematics was beset with the notice "Verboten." A boy might not use algebra in doing arithmetic; analysis was forbidden in geometry papers; calculus in doing analytical geometry or mechanics; while to mention a sine or cosine in the natural philosophy paper of a certain examining body would have been to pull the very whiskers of death.

Such, at least, were the facts as understood by those still *in statu pupillari* and as impressed upon them by their immediate teachers, whatever liberty the higher powers—the examiners—may have exercised in practice. But, above all, there must be no departure from the order of Euclid, and to use a later proposition in the proof of an earlier was mortal sin.

Now, here a distinction should be made: in part Euclid's order is essential to his general argument; but in part it is not and is merely matter of chance or convenience. For example, I. 16 (that the exterior angle of a triangle is greater than either of the interior opposite angles) of necessity comes before I. 32 (that the exterior angle is equal to the two together); and to use the latter to prove the former is a real error, betraying want of grasp of Euclid's argument.

On the other hand, his Sixth Book (on proportion and similar figures) does not depend on any proposition subsequent to I. 36 and I. 38 (that parallelograms and triangles on equal bases and between the same parallels are equal). Consequently, to use VI. 8 to prove I. 47 would not have been false logic, or an essential departure from his system, but merely a variation from the particular method he chose to adopt.

By sequence, then, we may mean either essential sequence, departure from which destroys the validity of the argument, or merely the arrangement of the subject-matter in an order dictated by convenience or taste, not by logic. Now, what is in the mind of those who desire a uniform sequence, whether agreed or imposed? We do not know; but it may be useful to consider the case for both kinds of sequence—that of logic and that of convenience. We will take the latter first.

It would, no doubt, be convenient, as boys frequently move from school to school, if all followed the same general order—taking, for example, the circle before similarity or vice versa. But agreement on an open question like this is unlikely, for each of the equally admissible orders would find strong advocates, and teachers keenly interested in their work would not willingly surrender their liberty.

The graver question, of course, is as to the logical sequence. But in fact, the current practice of schools has eliminated the question in this form; for the practice is now widespread (and the Assistant Masters' Association's Report will give it further currency) of beginning the formal study of geometry at a point where a sufficiently broad quasi-axiomatic basis has been established, namely, the conditions of congruency of triangles and the angle properties of parallel lines.

This means in effect the abandonment, or at least the postponement, of most of Euclid's propositions up to I. 32. Experience has shown that many of these individual propositions are not really grasped by the ordinary boy, and if these are omitted others become unnecessary, as they are mere links between the others. The advantage of the omission is that a boy can begin where the work is easy instead of where it is most difficult.

Two questions of great importance emerge, however, and it is probably to these that those who are, quite justly, dissatisfied with the present state of things should address themselves. First, how can we recover anything that we have lost by departure from the strict traditional system; and second, when, if at all, should boys be introduced to the initial difficulties which have been evaded?

As to the former, it is suggested that the proper guiding word is not "sequence," but "interconnexion"—that the idea required is not so much that of a single thread, as of a network of argument. It is an excellent practice to take a known proposition and trace its connexions backward. Thus the property of a cyclic quadrilateral depends on the relation between the angle at the centre and that at the circumference; this, again, depends on two early propositions, namely, the exterior angle of a triangle is equal to the two interior angles, and the angles at the base of an isosceles triangle are equal; the former depends on the angle properties of parallels, the latter on congruence. Following this process, wherever we begin, we always get back to one or both of these fundamental principles.

This illustration shows how grasp of sequence can be strengthened; as illustration of interconnexion take Pythagoras's proposition. It may be proved, as in Euclid, by use of parallelograms and congruent triangles; or by variants, using parallelograms only, which, however, depend on congruent triangles; but again it may be proved by the use of similar triangles (Euclid VI. 8). But similar triangles rest on the angle properties of parallels and on Euclid VI. 2, or the equivalent proposition as to the segments made on transversals by parallels, and this, again, depends on congruence. Similarly, it seems unwise to neglect either of the proofs of Euclid III. 35, 36 (rectangles contained by segments of chords); the proof by similarity is the easier and shows the inwardness of the proposition better; Euclid's proof brings out the important fact that the rectangle is equal to k^2-r^2, the "power of the point." Illustrations might be multiplied; but these will suffice to indicate what is meant, the habit of tracing connexions which gives mastery of the whole, and, it may be added, greatly increased power in what, after all, is the essential thing, the art of doing riders.

The second question does not, perhaps, as yet admit of so definite an answer: when and how far should pupils be asked to face the initial difficulties—congruence, parallelism, and the link propositions (*e.g.* inequalities) necessary for dealing with them? A partial answer may be given with some confidence: not until they have mastered the rest of the work and have gained power in solving problems. Beyond this it is not safe to dogmatise, but if geometry is worth studying for its own sake, for its beauty and essential interest, and not merely as an exercise in logic, it is quite possible, and, indeed, for most boys probable, that they will gain more by going on—by studying the ordinary developments not contained in Euclid, *e.g.* coaxal circles, pole and polar, inversion, etc., and geometrical conics, to say nothing of solid geometry—than by going back to examine first principles. Still in sixth form work, possibly in favourable circumstances in a fifth form, time might well be found for this; properly handled it would arouse great interest and would certainly be well within the power of the boys—as it is not within that of a third form. It involves, above all, the parallels axiom and some consideration of the relationship between axioms and definitions; in fact, it is quite as much a philosophic as a mathematical question. Its treatment would be rendered more effective by some knowledge of non-Euclidean geometry on the part of the teacher.

The Development of the Quantum Theory.

(1) *Molecular Physics.* By Dr. James Arnold Crowther. (Text-books of Chemical Research and Engineering.) Third edition. Pp. viii + 189. (London: J. and A. Churchill, 1923.) 7*s.* 6*d.* net.

(2) *The Quantum Theory.* By Prof. Fritz Reiche. Translated by Dr. H. S. Hatfield and Henry L. Brose. Pp. v + 183. (London: Methuen and Co., Ltd., 1922.) 6*s.* net.

To give an intelligible account of the modern theory of "quanta" is a difficult, if not an impossible, task. Many of the ideas involved are unfamiliar, and between them and the laws of orthodox physics lies an unbridged gulf. Our sympathy must therefore be extended to the authors of the two volumes under consideration in the attempts they have made to explain and elucidate the theory. Dr. Crowther has added an interesting chapter of an elementary character on quanta to his book on molecular physics, and although his treatment is, perhaps necessarily, somewhat didactic he has succeeded in bringing out clearly the difficulties to be faced and the method of meeting them. "The merit of Planck's theory is not so much that it removes our troubles altogether, but that it packs them all together into one bag, so to speak, so that they become easier to handle." Prof. Reiche has given an exceptionally lucid exposition of the origin and development of the quantum theory, and the translation of his book, which appears to have been carefully carried out, may be recommended to English-speaking students of the subject. It is to be regretted that the bad example of the German original has been followed in collecting together indiscriminately mathematical notes and references to the number of 325 in an appendix of more than fifty pages.

The birth of the quantum theory was December 14, 1900, when Dr. Max Planck, professor of theoretical physics in the University of Berlin, made a communication to the German Physical Society on the distribution of energy in the normal or "black body" spectrum. He described a new method of obtaining the formula (which he had announced a few weeks earlier), representing the way in which the energy is divided between the various frequencies which go to form the complete continuous spectrum of the radiation. In order to secure agreement with experimental results Planck was led to the hypothesis of energy quanta, according to which the radiation energy of any assigned frequency ν can be emitted and absorbed only as an integral multiple of an element of energy $\epsilon = h\nu$, where h is a constant of Nature, now known as Planck's constant. The numerical value first given by Planck was $h = 6{\cdot}55 \times 10^{-27}$ erg. sec., a value which is in remarkably good agreement with later determinations by several widely different methods. The fundamental relation of Planck's theory may be written in the form $\epsilon/\nu = nh$, where n is a positive integer. Thus h is a quantity of the dimensions of energy multiplied by time, that is of "Action" as that term is used in connexion with the Principle of Least Action, and the universal constant h represents a true *atom* of Action. Jeans remarks that "an attempt to imagine a universe in which action is atomic leads the mind into a state of hopeless confusion." Perhaps the attempt would be less bewildering were it possible to visualise more clearly the four-dimensional space-time world of Minkowski, in which action rather than energy is conserved. An element of this world may be regarded as an element of action.

In dealing with the radiation problem an incandescent body may be pictured as containing a large number of small oscillators, or Hertzian resonators, which are capable of acquiring energy and emitting radiation. In the first form of Planck's theory the fundamental hypothesis was that each resonator can acquire or lose energy only by sudden jumps, in such a way that its store of energy must always be an integral multiple of the quantum $h\nu$. Thus a resonator of high frequency can avail itself of energy only in large units, while a resonator of low frequency can absorb or emit energy in small quantities. It is not difficult to see that consequently the radiation will contain comparatively little light either of very short or of very long wave-length. There must be some intermediate value of the frequency corresponding to *maximum* emission of radiation, as is actually found to be the case in experiments on the distribution of energy in the spectrum of a "black body." By combining this conception of energy elements with Boltzmann's definition of entropy, Planck arrived at his celebrated radiation formula, which is found to agree closely with the results of observation. To minimise the difficulties associated with the discontinuous emission and absorption of radiation, Planck put forward modified forms of his theory later on, but many writers, including Poincaré, prefer the more drastic treatment originally proposed.

The failure at low temperatures of the law of Dulong and Petit, which assigns a constant value to the product of atomic weight and specific heat of a solid, may be explained if we abandon here, as we have already done in dealing with radiation, the principle of the equipartition of energy and make use, in some form or other, of the idea of a quantum. Einstein in 1907 was the first to attempt to solve this problem by applying the unitary theory of energy to the vibrational energy of the atoms of a solid. A more complete and satisfactory theory was put forward in 1912 by Debye, who, instead of assuming a definite frequency characteristic of a particular substance, imagined the solid capable of vibrating so as to yield a whole spectrum of frequencies from zero up to an assigned maximum. Still better agreement with experiment was secured by a modification of Debye's theory proposed by Born and Kármán. Prof. Reiche gives an excellent account of this theory, which regards the solid not as a continuous elastic substance, but as an arrangement of atoms in a space lattice.

Perhaps the most startling application of the quantum theory is found in the remarkable connexion between moving electrons and electromagnetic waves. When light of sufficiently short wave-length is allowed to fall upon a polished metal plate, negative electrons are set free with a velocity v which depends upon the frequency ν of the exciting light. The maximum kinetic energy of an electron ($\frac{1}{2}mv^2$) increases with frequency in agreement with a formula first suggested by Einstein on the basis of the hypothesis of "light quanta." This fundamental law of photo-electric activity may be written

$$\tfrac{1}{2}mv^2 = h(\nu - \nu_0),$$

where ν_0 is a definite frequency characteristic of the metal on which the radiation falls. The equation possesses a very high degree of generality, for it applies not only to ordinary light, but also to X-rays, and appears to be valid not only in the case of emission of electrons under the influence of light, but also when emission of radiation is brought about in consequence of the impact of electrons. The extraordinary problem involved in this reciprocal relation has been well put by Sir William Bragg: "It is as if one dropped a plank into the sea from a height of 100 ft., and found that the spreading ripple was able, after travelling 1000 miles and becoming infinitesimal in comparison with its original amount, to act upon a wooden ship in such a way that a plank of that ship flew out of its place to a height of 100 ft. How does the energy get from one place to another?" "In many ways the transference of energy suggests the return to Newton's corpuscular theory. But the wave theory is too firmly established to be displaced from the ground that it occupies. We are obliged to use each theory as occasion demands, and to wait for further knowledge as to how it may be possible that both should be true at the same time."

The quantum theory of spectral series, with which the name of the Danish physicist Niels Bohr will always be associated, is based on two fundamental ideas. The first is a natural extension of the principle involved in the photo-electric effect. Bohr argued that when an atom emits monochromatic radiation of frequency ν, it must be because the atomic system has lost energy of amount $h\nu$. But a second application of the quantum principle is required in order to fix the "stationary states" of the atomic system, that is, to determine the *permissible* orbits. By the application of these hypotheses Bohr was brilliantly successful in deducing Balmer's and certain similar series emitted by hydrogen, and the series in the enhanced spectrum of helium.

The later and more general formulation of the quantum theory put forward by Wilson, Sommerfeld, Ishiwara, and others, has linked together the various interpretations given for the quantum constant, and has made further progress possible in different directions. Sommerfeld, taking into account the dependence of the mass of the electron upon its velocity, has been able to explain and even to predict the fine structure of the lines in the simpler series, and has obtained results of great interest in connexion with X-ray spectra. Much light has also been thrown by the theory on the resolution of spectral lines under the influence of an electric or a magnetic field.

Attempts have been made with a certain measure of success to apply the quantum theory to explain the facts of magnetism, and the existence of discrete tubes of magnetic induction of strength h/e (where e is the electron charge) has been suggested. To meet the demands of the principle of relativity it may be necessary to postulate discrete electromagnetic tubes, or "calamoids," in four dimensions. Theoretically there is much to be said for the introduction of the "magneton," as one of the ultimate constituents of atomic structure. Here we are brought face to face with one of the outstanding problems of physics. Is the atom a solar system in miniature in which electrons are in rapid orbital motion about a massive nucleus, or is it possible to employ stationary electrons or magnetons to give an approximately statical model? The quantum mechanism imagined by E. T. Whittaker may yield an answer to this question. Then what are we to say as to the bearing of the quantum theory on the still more difficult question of the structure of the nucleus itself!

Prof. Reiche heads his last chapter "The Future," and propounds a series of questions still awaiting solution. "That there are discrete mechanical and electrical systems, characterised by quantum conditions and marked out from the infinite continuity of 'classically' possible states, appears certain. But where does the deeper cause lie which brings about this discontinuity in nature? . . . Is radiation really propagated in the manner claimed by the classical theory, or has it also a quantum character? Over all these problems there hovers at the present time a mysterious obscurity. In spite of the enormous empirical and theoretical material which lies before us, the flame of thought which shall illumine the obscurity is still wanting. Let us hope that the day is not far distant when the mighty labours of our generation will be brought to a successful conclusion."

H. S. Allen.

History of Medicine.

(1) *The School of Salernum: Regimen Sanitatis Salernitanum.* The English Version, by Sir John Harington. History of the School of Salernum, by Dr. Francis R. Packard, and a Note on the Prehistory of the Regimen Sanitatis, by Dr. Fielding H. Garrison. Pp. 216. (London: Oxford University Press, 1922.) 14*s*. net.

(2) *Life and Times of Ambroise Paré* (1510–1590): *With a New Translation of his Apology and an Account of his Journeys in Divers Places.* By Dr. F. R. Packard. Pp. xii + 297. (London: Oxford University Press, 1922.) 28*s*. net.

(3) *The Gold-Headed Cane.* By Dr. W. Macmichael. New edition. Pp. xxvii + 261. (London: Oxford University Press, n.d.) 16*s*. net.

THE growing interest in the study of the history of medicine to which the recent congress held in London testified (see Nature, August 26, 1922, p. 296), is further exemplified by the publication of these three fine volumes from the Oxford University Press under the editorship of Dr. Francis S. Packard, editor of "The Annals of Medical History." All the works in question are classics, and perusal of them forms an attractive introduction to the study of medical history, illustrating as they do the development of medicine at different periods.

(1) The "Regimen Sanitatis Salernitanum" is a handbook of domestic medicine written in verse for the benefit of laymen and particularly for Robert, Duke of Normandy, the eldest son of William the Conqueror, who on his way to the Holy Land passed a winter at Salerno in 1096. He visited it again on his return from the Crusades in 1099, to seek relief, it is said, for a poisoned wound of the arm which he had received in the war. As Dr. Garrison points out in an introductory note, in the 14th and 15th centuries there was a veritable flood of hygienic rules addressed to great lords and ladies for their use in travel, campaigns, or pregnancy, all dealing with dietetics, oral hygiene, care of the hair, sleep, etc. The authorship of the "Regimen" is doubtful. Although Daremberg, who published the most complete modern edition in 1830, regarded it as the work of several hands, it is generally attributed to John of Milan, who was head of the School of Salerno at the end of the 11th century. The text of the various copies in existence differs considerably in length. Thus the text annotated by Arnold of Villa Nova (1235–1311), which is used in the present edition, contains 363 lines, whereas some manuscript editions contain less, and others more than a thousand lines. The translation in this edition is that published in 1607 by Sir John Harington, a well-known scholar and courtier of the time of Queen Elizabeth, under the title of "The Englishmans Doctor or The Schoole of Salerne or Physicall Observations for the perfect Preserving of the Body of Man in Continuall Health." The English text is accompanied by notes and embellished by curious illustrations taken from old editions of the "Regimen." A list of the more readily accessible works dealing with the School of Salerno is appended.

(2) The volume dealing with Ambroise Paré will by many readers be found to be the most attractive of the three books under notice. It contains not only a translation in which the spirit of the original is well preserved, of one of Paré's most remarkable writings, but also an admirable sketch of the period in which he lived, including an account of the Faculté de Médecine, the Confrérie de Saint Côme, and the community of barber surgeons, as well as a chronological description of Paré's works. The "Apologie et traite contenant les voyages faits en divers lieux," of which Dr. Packard offers a new and complete translation, was written in answer to a book published in 1580 by Etienne Gourmelen, dean of the Faculté de Médecine, who attacked Paré for his treatment of wounds and his use of the ligature. After showing that he had been preceded in the use of the ligature by a host of great authorities, including Hippocrates, Galen, Avicenna, Guy de Chauliac, Vesalius, Jean de Vigo, and others, Paré relates the histories of cases in which he had applied the method with success. The rest of the work consists of a description of the campaigns in Italy, France, Germany, and Flanders in which Paré took part, and of those whom "he dressed and God cured." The book is copiously illustrated, there being 27 full page plates, 22 text illustrations, and two folded maps of Paris of the 16th and 17th centuries.

(3) A cane in previous centuries was the appanage of every physician, and was usually crowned with a hollow knob of gold, silver, or ivory containing aromatic substances to keep off contagion. The gold-headed cane which has given its name to this volume had a crutch-shaped handle. The book consists of the supposed narration of a gold-headed cane which originally belonged to Radcliffe, and passed successively into the hands of Mead, Askew, Pitcairn, and Baillie, whose

professional careers it describes. On the death of Baillie, whom Sir William Osler regarded as in many ways the most distinguished possessor of the cane, his widow gave it to Sir Henry Halford, who presented it to the Royal College of Physicians, in the library of which it now reposes.

The memoirs of the cane give a vivid account of the social and professional life of the leading London physicians in the seventeenth and eighteenth centuries, including descriptions of the early meetings of the Royal Society. Of special interest is the life of Dr. Mead, of whom it is said that "of all physicians he gained the most, spent the most, and enjoyed the highest fame not only in his own but in foreign countries." Apart from their professional attainments, Mead and Askew were highly accomplished scholars and ardent bibliophiles, the extent of their acquisitions being shown by the fact that the sale of Mead's library took twenty-eight days and that of the *Bibliotheca Askeviana* twenty days. The real author of "The Gold-Headed Cane" was Dr., afterwards Sir William Macmichael, censor to the College of Physicians on two occasions and subsequently physician-in-ordinary to the King. Macmichael also wrote a small and entertaining volume entitled "Lives of British Physicians." The first edition of "The Gold-Headed Cane" was published in 1827, two years after the opening of the present home of the Royal College of Physicians in Pall Mall, and the second edition appeared the following year. A third edition was published in 1884, or forty-five years after Macmichael's death, by Dr. William Munk, registrar of the College, who continued the narrative down to 1871.

Frontier Tribes of Assam.

The Lhota Nagas. By J. P. Mills. With an Introduction and Supplementary Notes by J. H. Hutton. (Published by direction of the Government of Assam.) Pp. xxxix + 255. (London: Macmillan and Co., Ltd., 1922.) 25*s*. net.

MR. MILLS'S monograph on the Lhota Nagas is a worthy supplement to the accounts of the Angami and Sema branches of the Naga tribes published by the enterprise and liberality of the Government of Assam, and written by Mr. J. H. Hutton, who has contributed a valuable introduction and notes to the present work. The volume contains a full description, pressed down and running over, of the life of this interesting people, who are now losing their identity by the influence of Christian and Hindu propaganda. A pleasant feature in the writer's work is the sympathy he shows for this childlike people, fully reciprocated by them, who showed their loyalty in the great war and claim to have defeated the Germans under the leadership of their white chief.

The most important part of the book is the introduction, in which Mr. Hutton, with unrivalled knowledge, sums up the latest conclusions on the ethnography of the Nagas. It gives a final blow to the methods pursued by the late Sir H. Risley and his school in dealing with the problems of Indian ethnology. Risley assumed that groups like Brahmans and Rajputs were homogeneous entities, and that it was possible by the measurement of a few skulls, collected haphazard, to

FIG. 1.—A Lhota warrior in full dress. From "The Lhota Nagas."

decide their position in his ethnological scheme. It has now been proved that these groups are in no sense homogeneous, and Mr. Hutton shows that the Naga tribes represent the convergence and assimilation of at least three streams of immigrants. "No Naga tribe is of pure blood, but the area which they inhabit has been the scene of immigrations from north-east, north-west, and south, and the different stocks introduced in this way have entered into their composition. Indeed, in view of the struggles that have taken place for the fertile plains of Burma to the east and India to the west, it is inevitable that some elements worsted in these struggles should have been pushed up into the hills." This is good sense and well expressed, and there is now no justification for accepting a hasty, ill-considered generalisation, or for assuming the division of the Indian races into a series of water-tight compartments, a view contradicted by the whole course of Indian history.

Among the elements which contribute to the formation of the Naga group of tribes must now be recognised the Negrito, because Mr. Hutton has detected among them examples of a type "with a decidedly dark-brown skin and fuzzy hair." But it is to the Mon-Khmer races, deriving their origin ultimately from China and later from Burma, that we must look for the main constituents of the Naga

Fig. 2. A medicine man (*Ratsen*) in a fit. From "The Lhota Nagas."

type. Mr. Hutton is possibly pushing the evidence a little too far when he suggests a comparison between a form of spear with ornamental barbs curving outwards from the shaft, a peculiar dao knife, and a shouldered hoe, with similar weapons and implements used by the Igorots of the Philippine Islands, as proving the common origin of these races. The general conclusion is quite acceptable, but it will need much further exploration to bring to light that amount of material by which so wide a generalisation can be established. But Mr. Hutton, who writes in a scholarly way and without any trace of dogmatism, is clearly working on scientific lines, and his admirable introduction throws much-needed light on the connexion of the races of eastern India with those of the Malay Peninsula and the islands farther east. It thus marks a decided advance towards the settlement of some of the most urgent problems of Indian ethnology.

Mr. Mills's work is an excellent example of field-work in ethnology, and it only remains to say that his monograph is furnished with a fine series of photographs, maps, and an admirable index compiled by Lieut.-Col. J. Shakespear.

Our Bookshelf.

An Introduction to the Chemistry of Plant Products. By Dr. Paul Haas and T. G. Hill. Vol. 2: Metabolic Processes. Pp. viii + 140. (London: Longmans, Green and Co., 1922.) 7*s*. 6*d*. net.

The first volume of this work is already well known to students of plant physiology; first issued in 1912, it is already in its third edition. In this third edition the more physiological problems were left for treatment in this second volume, which is in effect a completely new book. In the brief preface the authors describe their choice between the alternative methods of treatment, and every student will be grateful for their courageous decision to attempt a connected account of the present state of our knowledge rather than an encyclopædic digest of the literature. The result is a book much more open to criticism but infinitely more valuable.

After a brief introductory section, devoted mainly to modern methods of measuring and expressing hydrion concentration, the synthetic metabolism of fats, carbohydrates and proteins is briefly considered, and two long chapters dealing respectively with respiration and growth conclude a short but exceedingly suggestive volume.

In the reviewer's opinion, the authors have done a great service to botany by their clear, concise and eminently readable treatment of their subject. The brevity of the section devoted to fats probably adequately reflects our ignorance of their metabolism in the plant, though one would have liked to see reference to the recent investigations of Neuberg and his collaborators. The section on photosynthesis forms an admirable complement to the monograph upon carbon assimilation by Jorgensen and Stiles, which considers the same problems from a more physical point of view.

The treatment of protein metabolism is somewhat scanty, again a correct reflection of our ignorance, but an introduction to the recent work upon the relation of hydrion concentration to the chemical and physical behaviour of the amphoteric protein would have been very valuable for the English reader. The emphasis given to the dehydrase mechanism in the treatment of respiration seems to the reviewer entirely sound; until oxidase mechanisms can be proved more effective upon sugars, their significance as a general respiratory mechanism must remain under suspicion. The chapter on growth is very clear and well balanced; it is probably too early to hope for a critical treatment of the metabolic machinery of growth—at present there is very little metabolism in this chapter.

Among the Head-hunters of Formosa. By Janet B. Montgomery McGovern. Pp. 220 + plates. (London: T. Fisher Unwin, 1922.) 15*s.* net.

ALTHOUGH Mrs. McGovern's interesting account of the aborigines of Formosa is written for the general public rather than the scientific reader, it is welcome as a first instalment of the information she acquired during her two years' stay on the island. Our knowledge of these peoples is very defective, and the more detailed study which she promises will be awaited eagerly. In this book the author draws an attractive picture of a people of many virtues, notwithstanding their head-hunting proclivities. Their culture and social organisation are of considerable interest, not the least noteworthy feature being the existence of a matriarchate vested in priestesses. Their religion consists mainly in reverence for their ancestors, but among the Taiyals, whose mountainous country is subject to violent rain-storms, the rain-devil is naturally of much importance. They do not, however, propitiate him, but avert his unwelcome attentions by a ceremony in which the priestesses, armed with knives, engage in what is clearly a combat with the spirit.

The aboriginal tribes show no traces of totemism or exogamy, although the marriage of first cousins is strictly prohibited. Their language belongs to the Malayan family, and the author considers that the affinity to the Indonesian peoples, which has been suggested by other writers, is supported by the occurrence of the nose-flute and pile-dwellings among them. In this connexion it may be noted that the prominence of priestesses in religious ceremonies, the sacred character of certain jars, and the significance of birds as omens, find a close parallel in the customs of certain tribes of Borneo.

Bureau of Education, India. Occasional Report No. 9. The Planning and Fitting up of School Laboratories. By M. C. S. Anantapadmanabha Rau. Pp. vii + 40 + 8 + 18 plates. (Calcutta: Government Printing Office, 1921.) 1.4 rupees.

WORKS upon the material requirements of laboratories are very few, and as this subject is growing in importance published information is always to be welcomed. The first sixteen pages of the report deal with the general planning and relation of rooms and the arrangement and characters of the fittings they contain. In the remarks on construction it is surprising to see "brick nogged" partitions recommended as light suspended walls; in this country it has become rare even to find such construction in re-modelling buildings. The author proceeds to describe the fittings in detail, and while he gives a valuable summary every one will not agree with all his recommendations; thus he suggests lead for the bottoms of fume cupboards, and that the gas jet operating the draught should be placed at the top of the ventilating shaft near the exit, which would usually be a very inconvenient location. The plates which occupy the greater part of the volume give a series of good diagrammatic figures of fitting and plans of rooms, showing how these are laid out. These drawings are fully dimensioned and should prove of service in designing, though here again some difference of opinion may arise on the use of details; for example, metal handles, indicated for bench drawers, seem open to question. These are small criticisms and the volume will undoubtedly prove of considerable service.

A Summer in Greenland. By Prof. A. C. Seward. Pp. xii + 100 + 29 plates. (Cambridge: At the University Press, 1922.) 7*s.* net.

TWO months in west Greenland, where he went to collect fossil and recent plants in the summer of 1921, taught Prof. Seward the fascination of polar regions. Every chapter of this charming little book shows that the country has cast its spell over him. He does not attempt to justify his publication, but no justification is necessary. The book is a welcome addition to the literature of polar regions, for very little on Greenland has appeared in English in recent years. The author deals mainly with the botany and geology of the country, but there are some notes on its people and history, and a number of excellent illustrations and two maps. In the comparison of Arctic and Antarctic floras a correction may be made. Prof. Seward is mistaken in saying that not a single flowering plant has been discovered within the Antarctic Circle. The grass *Deschampsia antarctica,* which he cites from lat. 62° S., where, by the way, a true Antarctic climate occurs, was found, along with *Colobanthus crassifolius,* in lat. 68° S. in the west coast of Graham Land by the French Antarctic expedition in 1909. Another small point may be noted. Thule, in lat. 76° 35′ N., on the west coast of Greenland, is not the most northerly settlement in existence. Even if the Eskimo camp of Etah in lat. 78° 20′ N. be passed over, there is the large Norwegian coal-mining settlement of Nyaalesund in King Bay, Spitsbergen, in lat. 78° 55′ N.

Stories from the Early World. By R. M. Fleming. Pp. 156 + 12 plates. (London: Benn Bros. Ltd., 1922.) 15*s.* net.

THE success which has attended Miss Fleming's book, "Ancient Tales from Many Lands," has encouraged her to publish a second collection of tales dealing with the early world. In an interesting summary of the conclusion Prof. H. J. Fleure tells us that folk tales "have as their basis the interest of men in one another's ways when even neighbour people had very distinct civilisations." These tales cover a wide area and represent various phases of ancient life. One from America illustrates life before the domestication of animals, but recent investigation shows that cultivation is in many regions as old as herding. Many stories indicate the beginnings of trade and the social value of craftsmanship in the earlier development of settled life. That of Crœsus suggests the conflict between farmer-fishery in the Ægean and the warrior tribes of Media. That of Bilkis, Queen of Sheba, shows the Hebrews from the point of view of Islam, but Miss Fleming might have given the incident when Solomon hears that the Queen's legs were hairy, and forces her to raise her skirts in passing over the glass floor of his palace, believed to be a river, one incident which has parallels from India, strangely omitted in this world-wide survey. But folk tales must not be pressed too far as evidence of prehistoric or ancient life. They have wandered too much to be distinctive of special types of culture—what is permanent is the incident, which is combined in many ways according to the fancy of the story-teller. The book, as a whole, is interesting and suggestive, and supplies excellent reading for children.

Marine Works: a Practical Treatise for Maritime Engineers, Landowners, and Public Authorities. By E. Latham. Pp. xii + 174. (London: Crosby Lockwood and Son, 1922.) 16*s.* net.

THE scope of Mr. Latham's book is fairly wide, as may be seen from the following brief list of subjects treated: waves, maritime structures, tidal berths, pile-driving, marsh lands, coast defence, navigable rivers, scour and deep-water quays. There is also an appendix on legal aspects of maritime engineering. The treatment of these subjects is a little uneven. Some parts of the volume are detailed and contain much useful information, particularly in regard to unit cost prices of work actually carried out. Elsewhere, there is a superficiality a little out of keeping with the title of "Treatise." For example, in the first chapter the author states that "the theory of wave action is of little practical value," and dismisses the matter with some scanty reference to certain writers who would scarcely claim that their contributions to the literature of the subject are as weighty and authoritative as those by others whose names are ignored. This rather slighting allusion to theory is scarcely justified by the facts. There are other opinions and views expressed, to which exception might be taken, but apart therefrom, there is much that is useful as an addition to technical knowledge. The book is stated to be the outcome of sixteen years' professional practice, and as such should be of value to practical engineers.

(1) *Second Year College Chemistry.* Pp. xi + 311. 15*s.* net. (2) *Second Year College Chemistry: a Manual of Laboratory Exercises.* Pp. vii + 115. 7*s.* 6*d.* net. By Prof. W. H. Chapin. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.)

(1) PROF. CHAPIN'S book has, for English readers, a somewhat misleading title. It is not an elementary treatise on inorganic chemistry, but a clear and very interesting introduction to general and physical chemistry—"the general principles which are the framework of our science." The gas laws, atomic and molecular theories (including the periodic system, radioactivity and the structure of the atom), solutions, equilibrium, and electro-chemistry, are all reviewed from the modern point of view, and the result is a readable, accurate, and stimulating book for junior students in universities.

(2) This is a companion volume to the "Second Year College Chemistry." The experiments include an elementary course in practical physical chemistry, and some of them are new. Although the practical courses in English institutions are differently arranged, Prof. Chapin's book will be found useful by teachers in the physical chemistry laboratory, as well as by lecturers on this subject.

Secret Sects of Syria and the Lebanon: a Consideration of their Origin, Creeds, and Religious Ceremonies, and their Connection with and Influence upon Modern Freemasonry. By B. H. Springett. Pp. 351. (London: G. Allen and Unwin, Ltd., 1922.) 12*s.* 6*d.* net.

MR. SPRINGETT'S aim is to show that the rites of Freemasonry are derived from the mystic religions of the East. These, in turn, he holds, can be traced through the ancient religions of Egypt and Mesopotamia to the stellar and solar cults of prehistoric times. He attempts to prove his case by a statement of the esoteric beliefs to which initiates were introduced by a regular gradation in such early cults as the Eleusinian mysteries, Mithraism, Zoroastrianism, the doctrines of Pythagoras, the Gnostics, and the Manicheans, as well as in Mohammedanism and its various sects. He suggests that Freemasonry can be connected with these beliefs through the Knights Templar who, he holds, had probably adopted the tenets of the Manicheans and had been influenced to a considerable degree by the Ismæli, the followers of the Old Man of the Mountains, known to the medieval world as Assassins. It may be pointed out that in many cases our knowledge of these secret tenets is of doubtful accuracy, while the evidence against the Templars is of little value. Owing to the author's lack of archæological knowledge, many of his arguments will not bear critical examination, while they embody a number of errors in matter of detail.

Química Experimental. By Prof. Roman Galarza. I: Mineral. Curso de Química Científica, con los Principios Recientes de la Físico-Química, para Uso de las Escuelas Normales y Colegios Nacionales. Pp. 128. (Córdoba: Angel Alvarez, 1922.)

THE volume before us is an introductory treatise on a very original plan. There is a full account of laboratory arts, with many useful recipes and practical hints; a very interesting historical narrative, which embodies a good deal of material not usually met with; and a description of some of the common elements, including physical chemistry. The book would be found very interesting and useful by chemical students learning Spanish. There are some trifling errors: Newton "nacido en Voolsthospe," which reminds one of the English Alchemist "Germspreiser" [James Price] of Figuier.

More Beetles. By J. Henri Fabre. Translated by A. Teixeira de Mattos. Pp. viii + 322. (London: Hodder and Stoughton, Ltd., 1922.) 8*s.* 6*d.* net.

THIS is the fourth and last volume on beetles in the collected English edition of Fabre's entomological works. It is of special interest in containing the complete account of the habits of the dung-beetle *Minotaurus typhœus*, which, almost alone among insects, presents the phenomenon of the male collaborating for many weeks with the female in providing accommodation and provisioning the larder for the offspring. In several chapters Fabre's scorn of the theory of evolution is strongly in evidence, notwithstanding that he adduces numerous instances of exquisite adaptations of structures to the habits of individual species, and at least one of sexual selection.

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.*]

The Function of Mendelian Genes.

IN NATURE for January 20, p. 74, Prof. MacBride makes a statement which appears to me to rest upon a fallacy. Since this fallacy is not uncommon, and since it concerns a very fundamental problem, I feel that perhaps a discussion of it in these columns may serve a useful purpose.

Prof. MacBride, in the review referred to, writes as follows: "Prof. Reinke encounters the Mendelian 'gene' and in our opinion takes it far too seriously. . . . It is becoming every day clearer *that a 'gene' is not a definite unit of structure at all, but simply the measure of the amount of pathological damage which the hereditary substance has undergone.* [Italics in the original.] It is a measure, in a word, of the 'imperfection of regulation.'"

The fallacy involved is simply this—that Prof. MacBride is using the word "gene" as if it meant "mutant gene." A mutant gene is, strictly speaking, that portion of the hereditary constitution which is responsible for the characters of a mutation observed to arise in Nature or in the course of experiment. I take it, however, that Prof. MacBride is considering all definite variations which are inherited according to Mendel's laws, whether their origin was observed or no; this at any rate is now a legitimate extension, and I shall employ "mutant gene" to denote the altered portion of the hereditary constitution responsible for variations inherited in a Mendelian way.

Now in point of fact, as Morgan himself and other writers have taken great pains to point out, the discovery of each new Mendelising variation, of each new mutant gene, implies also the discovery of an allelomorphic "normal gene" responsible for the production of the "normal" structure and function of the part or parts affected by the mutation.

The work on Drosophila has completely proved that Mendelian genes are carried in the chromosomes. Prof. Bateson, for long sceptical on this point, finally conceded it last year after seeing the work of Morgan and his pupils at Columbia University, New York. Further, it has proved that within each chromosome the genes are arranged in a definite way; the observed facts are intelligible if we assume that the genes are arranged in a constant and linear order, while no satisfactory alternative hypothesis has been put forward.

In any case, the order is identical for all the homologous chromosomes of the species which are tested. A mutant gene, therefore, occupies a similar position in one particular chromosome to that which is occupied in the corresponding chromosome of the normal wild strain by an allelomorphic gene which has not mutated. The mutant differs from the non-mutant gene by some definite alteration, presumably of a chemical nature: the existence of series of multiple allelomorphs, together with other evidence, proves that a recessive gene is not a mere total absence of the something we call the dominant gene. That is to say, in the chromosomes of the normal wild-type animal or plant there exist a large number of genes or factors the chemical constitution of which cannot be altered without giving rise to "mutations." Some of these mutations are pathological; others (*pace* Prof. MacBride!) are not.[1]

[1] See *Science Progress* for 1921, where Prof. MacBride, in answer to two letters of mine, eventually admitted that not all were pathological. This question, however, does not concern the present argument at all.

But even if they were *all* pathological, this would not alter in the very slightest the fact that their non-mutant allelomorphs constitute an orderly series of discrete units distributed in heredity by the chromosome mechanism (*i.e.* according to the laws of Mendel as extended by later research), and *all* necessary for the *normal* development of the individuals of the species. Of course, if all mutations were pathological, Mendelian genes would have no significance for evolution. However, they would even so continue to have the most fundamental significance for normal heredity.

Perhaps my meaning may be made clearer by a brief example. In the wild house-mouse, each hair is black with a yellow band across it, the yellow and black blending to give an appearance of grey; grey of this type is technically called "agouti." Black mice are mutants in which the yellow band is absent; this condition is recessive to normal. Yellow mice, on the other hand, have the yellow pigment extending the whole length of the hair; and yellow is dominant to grey (agouti). It is also dominant to black. The three types of colour and their behaviour in crosses can only be explained if we suppose that there is a definite gene responsible for the production of yellow pigment, and that this exists in three separate states—a "strong" state when a great deal of the pigment is produced, a "medium" state in which a moderate amount is produced, and a "weak" or non-effective state in which no yellow pigment is formed at all. The gene in its medium state is responsible for the particular proportion of yellow which we see in the hair of wild house-mice. The three states are all allelomorphic to each other, the "normal" being a Mendelian recessive as against yellow, a Mendelian dominant as against black. It is impossible to escape from the idea of a discrete unit of definite composition helping to determine coat-colour in the normal animal, strictly comparable to the homologous units responsible for the two "mutations."

This example is also of service as regards the abnormality or otherwise of mutations and mutant genes. The alteration productive of all-yellow is decidedly pathological. Even a single dose of this gene leads to excessive fatness, and two doses cause death of the fœtus *in utero*. The recessive "black" gene, on the other hand, does not appear to be responsible for any pathological effects. What is more, there is no evidence against the view that this mutant black is strictly comparable to the black of melanistic mammals in Nature, and the similarity is so great that the onus of proof lies on those who would dispute this homology.

In any event, there are two quite distinct aspects of the gene question—the genetic or hereditary, and the evolutionary. Mutations in Mendelian genes may or may not have been responsible for variation which has played a part in evolution. This I do not propose to discuss here, except to say that I know from many conversations that Prof. MacBride's views are too sweeping for a number of zoologists. But as regards inheritance within the species, the Mendelian gene—once the fallacy of confusing "mutant gene" with "gene" is seen and avoided—is clearly and obviously of importance.

We are to-day in a position to make a calculation of the order of magnitude of the number of genes in the chromosomes of Drosophila. It is certainly more than 1000; probably more than 2000; certainly less than 20,000. The effects of alterations in more than 200 of these genes (*i.e.* mutations) have been observed and studied; there is no sign that the rapid stream of new-discovered genes is slackening. With such a number of genes responsible for keeping the development of a little fly in the straight and narrow path of normality, there seems very little room or need for subsidiary mechanisms of heredity. The cytoplasm presumably has its functions in this regard; but the absence of accuracy in cytoplasmic division, together with the presence of this large battery of genes in the accurately divided chromosomes, make us sceptical as to its possessing *many* "heredity-determining" substances. Finally, there is no reason to doubt and a good deal of reason to believe that all higher animals and plants possess chromosomal gene-complexes similar in essentials of structure and working to that so thoroughly analysed in Drosophila.

JULIAN S. HUXLEY.

New College, Oxford,
February 4.

Age and Area and Natural Selection.

I AM not especially eager to defend Dr. Willis's theory of "Age and Area." My chief interest in Dr. Willis's views is that they agree with those of Dr. W. Bateson and myself in accepting and confirming the conclusion that the distinctions of species have as a rule nothing to do with adaptation, and therefore nothing to do with Natural Selection.

Dr. Clark states (NATURE, February 3, p. 150) that every systematic zoologist whom he knows believes in Darwin's theory. But I long ago became convinced that the knowledge of systematic zoology, however profound and however accurate, confers no right to, and affords no justification for, the expression of opinions on questions of evolution, or at least on the causes and processes of evolution. To form a judgment on such questions requires certainly knowledge and experience of systematic zoology, especially of its principles and of the species in some particular group or groups of animals, but it also requires a practical knowledge of modern researches in genetics, of cytology, of certain branches of physiology, and of the life and habits of some group or groups of animals.

At the present time zoologists are usually specialists, and each specialist gives forth conclusions about problems of evolution based almost exclusively on the phenomena of his own special study. Dr. Bateson believes that no facts are of any great importance except those of genetics, that is to say, of the behaviour of characters in experimental breeding, and pays little or no attention to the question of adaptation. Prof. MacBride, on the other hand, a specialist in embryology, asserts that the characters and mutations studied by geneticists are merely pathological, and that all natural varieties are distinguished by differences of adaptation, due presumably to the action of external conditions. Dr. Clark apparently believes that diagnostic characters are all adaptive and to be explained by Natural Selection.

Dr. Clark states that his own special group is that of echinoderms. I wonder whether he has studied the mode of life of the species and varieties of echinoderms in Nature, and if he could bring forward any evidence to show a correlation between specific differences and differences of habit and mode of life. Many of the older systematists, holding no brief for any theory, recognised (and I think correctly) that there is a general distinction between characters which show natural affinities and are therefore most important in classification, and adaptive characters which are related to habits and conditions. Natural Selection is a theory of the origin of adaptations, and in my judgment there is ample evidence that specific differences are not as a rule differences of adaptation. Therefore Natural Selection does not explain specific differences. It is recognised now that in the cultivation of animals and plants the marked and constant characters which distinguish races are not, as Darwin believed, the gradual result of continued selection, but are mutations which have arisen spontaneously in definite form, not by successive stages. Does any one believe now that the rose comb in fowls is the result of a series of stages due to artificial selection?

If Dr. Clark would do me the honour of reading my book "Hormones and Heredity," he would find these matters more fully discussed, and would perhaps understand better why I consider the theory of Natural Selection to be obsolete. That conclusion, of course, is not disproved by the fact that many naturalists still believe in the theory, in America and elsewhere. But there are specialists in evolution as well as in systematic zoology and in other branches, and I venture to say that few who have made a special and practical study of evolution and are well acquainted with recent progress in that study, have much faith in Natural Selection.

It is evidence which is important rather than opinions, and I would ask what evidence Dr. Clark can bring forward to prove the adaptive value of specific and other diagnostic characters in echinoderms. Personally I am not interested in the explanation of the origin of species, but in the origin of the particular characters which distinguish one species from another.

J. T. CUNNINGHAM.

University of London Club,
21 Gower Street, W.C.,
February 5.

The Value of e/m.

IT is quite customary, at the present time, to use as the most probable value of e/m that derived by Paschen from spectroscopic data, as given by equations (12) and (13), page 272, and (15) and (16), page 275, of Sommerfeld's "Atombau," third edition. Taking Paschen's own estimate of the error in R_{He} and R_H, we have a probable error in e/m of about 0·2 per cent. But I have shown by a more detailed consideration of all available data (*Physical Review*, 17, 589, 1921) that Paschen's estimate of error for R_H ($\pm$ 0·06) is certainly too small, and that the true probable error is nearer $\pm$ 0·2. The latter figure leads to an error of 0·5 per cent in e/m, and the Paschen data, combined with the best data on atomic weights (4·002 and 1·0077 for He and H) result in $e/m = 1{\cdot}768 \pm 0{\cdot}009$, where the error in R_H has alone been considered.

Paschen used older and less accurate values for the index of refraction of air, in his reduction to vacuum. With the new values Bell (*Philosophical Magazine*, 40, 489, 1920) has shown that the value of R_{He} is raised 0·17 to 109,722·31. Since the calculation of this constant is independent of any particular assumptions as to the relative intensity of fine structure components, it is probable that this revised value is quite trustworthy, and I shall assume Paschen's own estimate of error, $\pm$ 0·04. The calculation of R_H is much more uncertain. Using the original Sommerfeld theory, as Paschen did, but all available data and the newer values for the reduction to vacuum, I have shown (*loc. cit.*) that Paschen's value of R_H is raised 0·14 to 109,677·826. But experimental results agree more closely with the more rational Bohr theory as to the intensity relations, and this theory yields a value of R_H lower by 0·21. Any lowering of the 2 to 1 intensity ratio of the Balmer series components leads to a lower value of R_H. I have suggested 109,677·7 as the most probable value of R_H, this being the mean value yielded by various theories. This value, combined with Bell's revised value of R_{He} gives 1·762 for e/m.

Finally, the new data by Wood (*Philosophical Magazine*, 44, 538, 1922) on the extended Balmer series makes possible a new computation of R_H. I find that these new measurements are entirely consistent with the previous data, and yield 109,677·6, with an assumed intensity ratio of 5 to 4. (A 1 to 1 ratio lowers this result 0·08.) There seems to be no question that the two fine structure components, with the exception of H_α and H_β, are of nearly equal intensity. I am therefore inclined to consider 109,677·6 as a preferable value for R_H, and this yields 1·758 for e/m, a value for which the probable error is fully 0·5 per cent. The point I should like to emphasise is that the newer experimental results for hydrogen indicate that $R_{He} - R_H$ must have a larger value than that computed by Paschen, and hence e/m must be smaller, but that the probable error is much greater than that assumed by Paschen. I have previously (*Physical Review*, 14, 363, 1919) used 1·773 as the most probable value of e/m, and while this value may be slightly too large, I still feel that it is more trustworthy than the spectroscopic value of 1·758. Without a considerable advance in our experimental knowledge of the fine structure of the hydrogen lines, it is scarcely possible to diminish appreciably the uncertainty in this latter value. New experimental data on the value of e/m, derived from deflection experiments or from the Zeeman effect, are greatly to be desired.

RAYMOND T. BIRGE.

University of California,
January 11.

Sir Christopher Wren's Science Museum.

At the present time, when the thoughts of all are being directed to the fifty churches and innumerable other buildings that are associated with the name of Wren, reference may appropriately be made in NATURE to his epoch-making work for science during the best twenty years of his life, to his scientific instruments, and to his Science Museum (Fig. 1). His instruments, after having been piously preserved for many years in the repository of the Royal Society at Gresham College, have now vanished, but his building, the Old Ashmolean Museum, is still standing, though no longer used for the purpose for which it was intended.

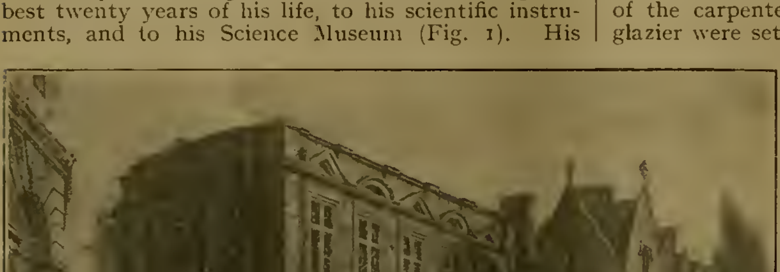

FIG. 1.—Wren's Science Museum at Oxford. (After Mackenzie and Le Keux, Memorials, 1834.)

Since the destruction in 1767 of Gresham College, the venerable seat of learning and science, where the original members of the Royal Society used to hold their meetings, no existing building is more closely associated with the spirit of the time of the foundation of that society than is the Old Ashmolean Museum.

On the occasion of the 300th anniversary of the birth of Ashmole, this building was described in NATURE of May 17, 1917, as our first public Museum of Natural History, and now, on the occasion of the bicentenary celebrations in honour of Sir Christopher Wren, we would emphasise the intimate connexion it has with the great architect, who owed much of his surpassing merit in the arts to the preliminary training that he had in Oxford as a man of science.

Elmes, in his "Life of Wren" (1823), attributes the Ashmolean Museum to him, but as some recent writers have cast a doubt upon the matter, I have examined all available materials, and have come to the conclusion that there is every reason for upholding the correctness of Elmes' attribution. According to the Vice-Chancellor's Accounts, the building of Dr. Ashmole's Repository took about four years (1679–83), during part of which time Wren was engaged on other important works in Oxford. It was erected only a few yards from the Sheldonian Theatre, his earlier work: a science museum would scarcely have been placed so near without having consulted Wren. There is no record of any fee having been paid to him, but he would have known that the University was barely able to meet the building expenses of the new Museum, and it is known that on occasions he gave his services free. As president of the Royal Society, and as builder of some half-dozen churches in London, he was fully occupied elsewhere during the construction; and the work of supervision was entrusted to Mr. Davis, the University Bailiff, who received 80*l.* for this service. Wood, the stone-cutter, received 1912*l.* 5*s.* 5*d.* for the masonry work, and the accounts of the carpenters, plaisterer, plumber, painter, and glazier were settled separately.

A finely designed portal, flanked by columns and opening under a richly ornamented canopy, leads into a large room running the whole length of the building, about 58 ft. 6 in. long by 24 ft. 10 in. wide. It is lit by five high windows on the north side. On the upper floor a similar room has been divided into two, which are perhaps the best lit rooms in Oxford, having large windows on three sides, N., S., and E. or W. It is necessary to emphasise this point, because a contrary statement, disparaging Wren's building, appeared in the *Times* for December 2, 1922. The windows are about 10 ft. high by 4 ft. 6 in. wide, and there are no dark corners anywhere.

The illustration printed with this letter shows the balustrade round the roof of the building. It is the counterpart of the contemporaneous work at Christ Church, and of the earlier work on the Sheldonian Theatre. Wren was very partial to balustrades. Moreover, it stands within the railing that was undoubtedly designed by him.

When recalling the connexion of the Museum with two of the first fellows of the Royal Society—Wren and Ashmole—the link with the founder of the Society should not be forgotten; the monogram of Charles II.—"C. II."—is carved over the fine balcony window in the middle of the front of the building.

It is on account of these various associations with British science and the early days of the Royal Society that a petition has been laid before the Hebdomadal Council of Oxford, requesting that the vacant rooms in the old Museum may be once more used for the purposes of natural science for which they were built.

R. T. GUNTHER.

Magdalen College, Oxford.

Tesla Spectra of Complex Compounds.

IN NATURE of January 27, p. 115, a very interesting letter appeared by J. K. Marsh and A. W. Stewart on "Tesla Spectra and the Fraunhofer Effect in Complex Compounds."

More than a year ago I began an investigation of the band spectra of benzene vapour under the action of high-frequency discharges. Both the absorption and emission spectra were examined. Other more complicated substances were also tried in a state of vapour.

Upon varying the capacity, and more especially the self-induction, as well as altering the vapour pressure between wide limits, *emission* bands can very clearly be seen. Each substance has a characteristic spacing of the emission bands; they appear in a perfectly definite order. Nitrogen is a very good example of this.

In the case of benzene, I photographed a whole series of emission bands which lie very close to its absorption and fluorescence bands. I referred briefly to this in my article on "Spectres d'absorption et de fluorescence du benzene" (*Journal de Physique et le Radium*, Juin, 1922, p. 210).

J. K. Marsh and A. W. Stewart express the wish to reserve for themselves the further examination of Tesla spectra. I should only like to say here that we have been working for a long time on similar ground, but one thing is certain, that we have been working from entirely different points of view. Our principal object is to work out the structure, size and shape of the molecules from their band spectra.

Our investigations, and those of Messrs. Marsh and Stewart, should therefore be of mutual advantage one to the other.

The subject is so vast that the more it is investigated, the sooner will the question of the band spectra be solved.

VICTOR HENRI.

Institute of Physical Chemistry,
University of Zürich,
February 2.

WHEN our letter to NATURE of January 27 was written, we were under the impression that we were the only workers in this field, as the researches of Wiedemann, Eberts, and de Hemptinne in 1897 and earlier years had led to no results in the particular region which we were investigating. Prof. Henri has courteously sent us a private communication as well as the above letter, and has forwarded also a copy of the paper which he mentions. In this paper occurs the following sentence: "Nous avons entrepris une série de recherches pour étudier la fluorescence et la luminescence de la vapeur de benzène sous différentes conditions, en particulier sous l'influence de décharges électriques diverses." As was natural in the case of a long paper, this sentence was not reproduced in the abstract which appeared in the Chemical Society's Journal; and as we had no access to the *Journal de Physique et le Radium* itself, we were quite unaware that any one was working in the field. Thus our work and the unpublished results of Prof. Henri are entirely independent of each other; and we are anxious that the mere accident of our having been first in actual publication of detailed results should not in any way deprive Prof. Henri of his full share in the credit of the discovery and investigation of these new spectra.

As Prof. Henri says in his letter, the subject is being approached along two separate lines, as we are mainly interested in the relation between the chemical constitution of substances and the spectra produced by them, whereas he is working back from the spectra as a basis to the machinery which produces the spectra within the molecules and is investigating also the variations produced by different electric wave-lengths—a subject which we have no intention of entering upon now, since it is in his hands. Our lines of research therefore supplement each other; and we cordially agree with Prof. Henri that there is more than enough room for both our laboratories to work in this interesting new field. We should like to express our appreciation of the courtesy which Prof. Henri has shown in this matter.

J. K. MARSH,
A. W. STEWART.

The Sir Donald Currie Laboratories,
The Queen's University of Belfast,
February 8.

Calendar Reform.

DURING the 16th century Pope Gregory XIII. effected a very necessary rectification of the Julian Calendar, which was not, however, legally adopted in England till 1752. The effect of the correction was to bring forward the dates of the solstices from about the tenth to the twenty-first of June and December; but the climatic significance of this astronomical dislocation in the calendar was not serious, and the calendar months retained the same distinctive seasonal characters as heretofore. As, therefore, the present calendar is the same in essentials as that instituted by Julius and Augustus Cæsar some 2000 years ago, it must have come as a surprise, possibly a shock, to many readers of NATURE (December 2, p. 747) to learn that we may shortly be asked to suffer all the inconvenience and confusion of a catastrophic alteration in the calendar on grounds which seem altogether trivial. In the first place, the calendar months now in use have by long association become enshrined in literature as the very impersonation of definite stages in the seasonal progression and retrogression of natural phenomena, and it would be sheer vandalism to break this association, and renounce our literary heritage, without far graver practical cause than can possibly be shown.

In the second place, every calendar system must be framed with reference to the four natural landmarks of the year, namely, the solstices and equinoxes, and it is eminently desirable that the two solstices, and the two equinoxes, which stand opposite one another in the natural year, should not be assigned dates which are unsymmetrically disposed to one another. In the proposed system of 13 months, the solstices would stand $6\frac{1}{2}$ months or time-units apart, instead of a whole number as in the present system, and no month would be located diametrically opposite another as at present, viz. December to June, March to September, and so on, along the earth's orbit round the sun. This arrangement would offend the artistic sense of any one with a vivid appreciation of the fact that our fundamental division of time, the year, is not an arbitrary unit but one based on a grand cycle of Nature.

Thirdly, it is said that meteorologists and astronomers would welcome months with equal numbers of days, and no doubt they would, one and all, if they could order everything to perfection. But apart from the labour that would be involved in preserving the continuity of the climatological record, involving the translation of one calendar into the other, think of the confusion that would arise in making comparisons between two systems which both have the same names of months! We should be perpetually having to think and specify whether it is the old *January* or the new *January* we are considering, and so forth. It would be just as though, when the new barometer unit the *millibar* was instituted to replace the *inch*, the name "inch" had been retained for the new division. Far better would it be to have an entirely new set of calendar names so that the old names would retain their habitual meanings. It is always open to astronomers and meteorologists to invent a system for any special technical purpose for which it may be required; but probably not many of them would take the narrow view and wish to disorganise the world on that account.

This country can, when it likes, be very much to the fore when issues of real importance are involved; but with a sane respect for tradition it is scarcely likely to countenance interference with a system of time-measurement the correction of which by Pope Gregory XIII. was designed to hold good for a very long period ahead. L. C. W. Bonacina.

27 Tanza Road, Hampstead, N.W.3.
January 27.

Time Relations in a Dream.

I was much interested by Dr. Atkins's letter in Nature of January 27, p. 117, about time-rate in dreams, and more especially by what he says of the metallic nature of the sound as heard in the dream. This fits in with an observation I made a couple of years ago when I was in lodgings close to a bell-tower. It happened that for other reasons I was not sleeping well at the time, and was frequently waked by the bell ringing hours and quarters. It always seemed then of much higher pitch when I heard it in a dream, or even when I was just awake enough to recognise the source of sound, than when I was fully awake. Several times I could follow the same sound repeated during my transition from sleep to waking, and then found that I really heard the upper notes of the bell in their true pitch, the lower notes being completely blocked out.

Though I have since been able to verify this interpretation nearly to my own satisfaction, I should be glad if any one else could confirm it in any way, as, in the nature of the case, it is difficult to be certain of one's judgment. Can the physiopsychologists help towards an explanation, assuming I am right?

H. F. Biggs.

The Electrical Laboratory,
Oxford, January 29.

The Ascent of Elvers in Egyptian Waters.

In connexion with Dr. Schmidt's article on the "Breeding Places and Migrations of the Eel" (Nature, January 13, p. 51), it may be of interest to give the results of further observations upon the arrival and ascent of elvers in Egyptian waters. The records were made at the pumping-station mentioned in Dr. Schmidt's article. The station is exceptionally favourable for such observation, since skilled observers were (and are) present day and night (in connexion with other fishery work) throughout the year. There can be no doubt, therefore, that when elvers were reported absent there were in fact none to be seen. Since the pumping-station ceases to work early in the summer, this fact may bring the ascent artificially to an end; but, as a rule, there are signs that the main run is over before the pumps stop. The numbers transported are given as an indication of the extent of the "runs."

All the early "runs" consist of transparent elvers; from the middle of April onwards about 50 per cent. are pigmented.

The observations are as follows:

1919–1920 Season: No observations prior to January 20, 1920, on which date transparent elvers were abundant and remained so until April 15, when the pumps stopped working. Reappeared in large numbers on the nights of July 2, 3, and 4. Total transported, 6,260,000.

1920–1921 Season: First observed December 15, 1920 (also on some date in Lake Menzaleh, near Port Said); remained few till January 30, when they appeared in large numbers for two nights only; then disappeared completely until April 7, when they were present for three successive nights. Appeared again April 19–May 24, when pumps ceased working. Total transported, 1,797,000.

1921–1922 Season: First observed on November 11, 1921, in small quantity till January 20, 1922; remained abundant till February 20, 1922; disappeared till March 23, continuing in decreasing numbers until April 10, when pumps stopped. Total transported, 2,484,000.

1922–1923 Season: First observed October 25; remained in small numbers until December 4, when they were abundant for two nights; remained few in number to date, January 24, 1923.

From the above, it may be observed:

(1) That elvers may make their first appearance at a given place nearly two months later in one year than another.

(2) That the dates of first appearance in Egypt are the same as those recorded for the West of Ireland, France, and Spain—say, 1500 miles nearer the suggested centre of dispersal in the Western Atlantic.

(3) That the main "runs" occur in the same months (February–April) in rivers as widely separated geographically as the Severn, the Po, and the Nile, notwithstanding the very different climatic conditions obtaining in these months in the last-named region.

G. W. Paget.

Coastguards and Fisheries Service, Cairo.

Transcription of Russian Proper Names.

In order to conclude the discussion which followed my proposal to use letters of the Czech alphabet for the above purpose (Nature, April 29, 1922, p. 552)—a proposal which was opposed by Lord Gleichen and Mr. J. H. Reynolds and defended by Messrs. Druce and Glazunov (Nature, November 11, p. 635, and October 14, p. 512)—I tried to find out the opinion of the Academy of Petrograd about this matter. At last, only recently, I have succeeded in obtaining from one member of the Russian Academy of Sciences a copy of a publication: "Memorial book of the Imperial Academy of Sciences for 1914—published March 20.—S.-Petërburg 1914." This contains on p. 180 a "Transcription of Russian Proper Names, approved by the Imperial Academy of Sciences (accepted in the Conference at the meeting of December 2/15, 1906)." To this table six notes are added containing rules concerning the cases in which to use or not to use for transcriptions of vowels the Czech *j*, referred to in the table under (1)-(5).

а	б	в	г	д	е[2]	ё[5]	ж	з	и[3]	і	й		
a	b	v	g	d	e, je	ë	ž	z	i, ji	i	j		
к	л	м	н	о	п	р	с	т	у	ф	х	ц	ч
k	l	m	n	o	p	r	s	t	u	f	ch	c	ć
ш	щ	ъ	ы	ь[4]	ѣ[2]	э	ю[1]	я[1]	ѳ	ѵ			
š	šč	–	y	ĭ	ě, jě	e	ju, ĭu	ja, ĭa	f	i			

For brevity's sake I do not translate the single notes.

I lived long enough in England to love the nation and appreciate its wonderful conservatism, and I quite understand that English geographers will scarcely give up the transcription once introduced by Lord Gleichen (of which I also possess a copy); yet a glance at the special Ordnance maps of countries of Central Europe, for example the excellent maps (1 : 75,000 or 1 : 25,000) of the late Austrian Empire, might convince everybody that the diacritic signs of half-a-dozen different languages are not a drawback in producing or using such maps even for military purposes.

Thus the nations outside Great Britain will have to choose between the mode of transcription defended by Lord Gleichen or the rules given by the Russian Academy of Sciences, which—up to this date having been unknown to me—happen to coincide with my proposal.

BOHUSLAV BRAUNER.

Bohemian University, Prague—VI.
February 1.

Herapath's Artificial Tourmalines.

I SEE that Prof. F. J. Cheshire (NATURE, February 3, p. 171), in his presidential address to the Royal Microscopical Society, urges "that the work of Herapath and others in the production of artificial tourmalines should be again taken up," and I wish strongly to support this hope. In my report in the War Office "Observations on Malaria" (1919) I showed that the Herapath test for quinine, especially as modified by Prof. W. Ramsden, is the most delicate test known for this alkaloid, and I feel certain that Herapath's method lends itself to many other applications. I have never found it to fail in the case of quinine, which I was able to detect even in dilutions of 1 in 15,000,000.

M. NIERENSTEIN.

University of Bristol,
February 6.

The Mechanism of Audition.

IN connexion with the recent discussion in NATURE of the mechanism of the cochlea, and of the model of the cochlea designed by Mr. George Wilkinson (October 21, p. 559; November 11, p. 632), it seems well to point out another characteristic of hearing which will have to be taken into account in any comprehensive theory of audition. This is the abruptness of the changes which are found in the sensitivity of many ears when tested as a function of frequency. These are disclosed by the accurate determinations of the sensitivity-frequency characteristics of ears which have been made possible by the use of continuous ranges of pitch for acuity tests instead of the method of tests at discrete frequencies which has usually been used. A description of the apparatus used is given in an article soon to appear in the *Physical Review*. In some cases with apparently normal hearing people, changes as great as a factor of one thousand in the necessary intensity for audition are found with a change of pitch of a semitone, these occurring in connexion with depressions in the general level of sensitivity. Pictorially, this would seem to require the physical existence of a large number of elements each of which is concerned with the transmission of only a very narrow range of frequencies, these differentiated elements existing in the inner ear, in a possible cable from the ear to the brain, in the brain itself, or possibly in all three places, and of such a nature that the individual elements may be quite severely injured without seriously affecting neighbouring elements.

FREDERICK W. KRANZ.

Riverbank Laboratories, Geneva, Illinois.

Spiranthes autumnalis.

IN NATURE of February 10, p. 185, Prof. Bower describes the finding of the orchid *Spiranthes autumnalis* near Carrbridge in the summer of 1921. I have to report the discovery of a single specimen of this orchid in the first week of September 1922, on Docharn Craig, a small hill (1250 ft.) four miles south-east of Carrbridge. The hill is under cultivation up to 1100 ft. on the southern side, but on the northern side there are the remains of a wood of magnificent wind-sown pines. The floor of the wood is covered with *Vaccinium* spp. (mainly *oxycoccus*), mixed in places with *Erica Tetralix* and *E. cinerea*: earlier in the season *Pyrola rotundifolia* and *Trientalis europea* were abundant. Only one plant of *Spiranthes autumnalis* was found, although the interest attaching to its unexpected discovery in this locality led to a careful search of the whole wood. The specimen was unfortunately lost in the transit to town, but when fresh it was quite unmistakable.

E. PHILIP SMITH.

46 Murrayfield Avenue,
Edinburgh, February 11.

PROF. BOWER'S letter in NATURE of February 10, recording the finding of *Spiranthus autumnalis* near Carrbridge, Inverness-shire, prompts me to record the presence of that orchid in the Island of Coll, Argyllshire.

Whilst surveying there in August 1921 my wife and I noted some half-dozen specimens. These, though undoubtedly of the genus Spiranthus, did not tally exactly with the description of *S. autumnalis* as given in Hooker's Flora, but the difference was not sufficient to make them a variety.

Unfortunately we have not preserved a specimen, but we were so surprised at the time at finding that species in Coll that we sent one specimen to a competent field botanist who confirmed our identification.

JOHN B. SIMPSON.

H.M. Geological Survey Office,
33 George Square, Edinburgh.

The Drayson Paradox.

THE writer of the first paragraph in the astronomical column of NATURE of January 20, page 94, refers to my pamphlet (Wm. Pollard and Co., Exeter, 1s. 6d.) in a way which might lead an incautious reader to suppose he had seen it, which evidently he has not, or he would scarcely speak of "wresting a few isolated observations to suit their preconceived views" in face of the statement on its nineteenth page that "the *general consensus* of the stars supports the result given." A proof of that statement, a quantitative proof, will be found on pp. 42-44. I cannot encroach on your space to quote it here, but may briefly indicate its nature: P being the pole of the heavens and E the pole of the ecliptic, let P E C be a spherical triangle having E C 6°, P E 23° 27′, and P E C 174° 28′. Describe a small circle with C as centre and C P as radius: then will W, where E C produced cuts the circumference of the circle, be that spot where is situated the so-called "Apex of Solar Motion." The sides and angles given are not arbitrary but depend upon the rate of precession and of the decrease in the obliquity at the commencement of this century, as is shown on page 44 of the pamphlet.

This is a geometrical problem the significance of which your astronomical readers will readily appreciate. The facts it rests on are undeniable, and no alternative explanation to that suggested has hitherto been forthcoming.

A. H. Barley.

Leppington House,
Hertford.

Mr. Barley's "incautious reader" would be quite correct in supposing that I had not only "seen" his pamphlet but read it carefully. It is not my practice to review works that I have not seen. I have, indeed, followed Draysonian publications with a melancholy interest from my youth up, and I cannot but regard them as an example of ingenuity misapplied.

Mr. Barley in his letter does not touch on the points I made (1) that if the proper motions of stars were due to any shift of the earth's axis, all the stars in a given direction would move together, and there would be no relative shift among them. But in examining photographs of the regions round stars with sensible proper motions (say Capella) the P.M. star is clearly seen to be moving among the faint stars in the background at practically the same rate as that given by the meridian observations. Indeed, Prof. Furuhjelm was enabled to detect a very distant companion to Capella by its sharing in its rapid motion relatively to the neighbouring stars. What is it then but "wresting" evidence to deny the reality of Capella's motion. (2) Mr. Barley denies the fact that the ecliptic is moving among the stars, and quotes Drayson as having tried to establish from the observations of Hipparchus that such motion did not exist. This to me appears another flagrant example of wresting isolated observations.

Hipparchus's results were liable to errors of several minutes of arc, whereas modern results are accurate to a second or thereabouts. Hence we can get a better result from 50 years using modern observations, than from 2000 years using those of Hipparchus. The modern observations show unmistakably that the ecliptic is shifting. Of course it is impossible to give all the evidence for this in the course of a letter, but I have arranged a small number of observations in a way that will show an unbiassed reader that such is the case.

The following table gives the North Polar Distance of the star ι Geminorum as observed at Greenwich in different years, and also the North Polar Distance of the sun interpolated for the moment that its Right Ascension was the same as that of the star. It is to be noted that the N.P.D. of the star is referred to the mean equator of the year, that of the sun to the apparent equator affected by nutation; we can correct for this approximately by combining observations made about nine years apart when the nutation is opposite in direction and amount.

NORTH POLAR DISTANCE

Year.	Star.	Sun.	Star South	Mean.
1836	66° 44′ 7·71″	66° 32′ 39·05″	11′ 28·66″	
1844	66 44 5·51	66 32 49·42	11 16·09	11′ 22·18″
1855	66 44 1·70	66 32 39·92	11 21·78	
1876	66 43 55·85	66 32 39·54	11 16·31	11 5·04
1885	66 43 54·99	66 33 1·23	10 53·76	
1902	66 43 51·90	66 33 2·57	10 49·33	10 54·79
1911	66 43 51·65	66 32 51·40	11 0·25	

It will be seen that in sixty-one years the sun's path has moved southward relatively to the star 27·4″. The star itself is moving south 10·8″ per century (Boss), so this has to be added to the southward movement of the ecliptic. It will be understood that I give these figures merely to demonstrate the reality of the movement of the ecliptic, not to determine its exact amount, for which further refinements would be necessary. I chose a star near the solstitial colure (1) because difference of N.P.D. practically agrees with difference of latitude, thus saving reduction; (2) because this is the neighbourhood where the ecliptic is moving south most rapidly. I reiterate my advice to Mr. Barley to study the whole of modern astronomy of position, instead of confining himself to a few selected portions, which he interprets in a way that further study would show to be untenable.

The Writer of the Note.

The Naming of Elements.

Surely the time has come to abandon the practice of attaching to elements fancy names arbitrarily selected by individuals. When names concerned nobody but a small clique in constant personal communication, and when they had nothing more important to record about an element than the personality of its discoverer, there may have been something to say for the system. Nowadays neither condition is fulfilled. Thousands are interested who have no means of expressing their opinion: and there is something definitely scientific to be said about elements. The new element was discovered as a consequence of a theory of the structure of the atom, and its discoverers should surely be glad to see a record left in the name that their discovery was no lucky fluke.

Dr. Aston, who has discovered at least twice as many elements as anybody else in the history of science, has set a good example; he has waived his right of naming, undoubted under the old dispensation. He has left them unnamed until a consensus of scientific opinion has established a scientific system of nomenclature. Will not others follow his lead? Until its isotopic constitution is discovered, let us simply call the new element 72.

Norman R. Campbell.

Sarsen Stones.

Referring to the note on the discovery of the above near Maidstone, which appeared in Nature of February 10, p. 195, may I direct attention to the fact that they occur in considerable numbers of large size, often in groups, near Faversham. The botryoidal concretionary surface-feature is frequently present, but what appears to be of greater interest is that many of the blocks are perforated by long, tubular holes suggestive of the work of marine annelids anterior to the consolidation of the rock. The gravel pits in this district yield large masses of sarsen occasionally. One stone I found recently weighs more than 2½ cwt., and can now be seen at the Twickenham Public Library. Full particulars appeared in the local press (*Richmond and Twickenham Times*, December 23, 1922).

C. Carus-Wilson.

Twickenham, February 19.

Poisoning by Illuminating Gas.

DURING the last few months much attention has been given in the public press to the question of the poisonous properties of illuminating gas and the risk to life which may be incurred if an escape of gas should take place in an ordinary dwelling. The only constituent of illuminating gas which has serious poisonous properties in this connexion is carbon monoxide.

Carbon monoxide has the property of forming a dissociable compound with the hæmoglobin of the blood just as has oxygen, but the affinity of carbon monoxide for hæmoglobin is about 240 times that of oxygen for hæmoglobin. The greater the extent to which the hæmoglobin becomes combined with carbon monoxide the less is its capacity to act as a carrier of oxygen between the lungs and the tissues of the body, and if sufficient of the hæmoglobin in the blood becomes combined with carbon monoxide the normal oxygen supply to the tissues must evidently be seriously affected. The effects produced by severe carbon monoxide poisoning are, in fact, those of slow or rapid asphyxiation.

If blood is exposed outside the body to air containing both oxygen and carbon monoxide the partition of the hæmoglobin between the two gases follows the laws of mass action, being determined by the relative partial pressure of the gases, allowance being made for the difference in their affinities. The air in the lungs with which the blood undergoes gaseous interchange contains in man about 14 per cent. of oxygen when he is breathing ordinary air. If human blood is saturated *in vitro* at body temperature with an atmosphere containing 14 per cent. of oxygen and $\frac{1}{240}$ of this proportion of carbon monoxide, *i.e.* 0·058 per cent., the hæmoglobin will finally become equally divided between the two gases, or 50 per cent. saturated with carbon monoxide and 50 per cent. with oxygen. If the concentration of oxygen is kept constant and that of carbon monoxide is varied the degree to which the hæmoglobin will become saturated with carbon monoxide is as follows:

In the Presence of 14 per cent. of Oxygen.

Percentage of carbon monoxide.	Approximate final percentage saturation of hæmoglobin with carbon monoxide.
0·015	20
0·03	33
0·06	50
0·12	67
0·17	75
0·23	80

If a person is exposed to ordinary air containing carbon monoxide the hæmoglobin in his blood will gradually become saturated with carbon monoxide just as in the experiments *in vitro*, and the degree of saturation will finally attain a steady value dependent on the precise concentration of carbon monoxide in the air that he is breathing. The symptoms that result will vary with the degree to which the hæmoglobin is saturated with carbon monoxide. If the hæmoglobin is 20 per cent. saturated the effects are practically unnoticeable to a normal healthy man, though headache may be caused by prolonged exposure or appear subsequently after reaching fresh air: even with 33 per cent. saturation nothing of a really serious nature occurs, though nausea and headache may be felt after some time, and transitory giddiness and confusion will occur after any short and severe muscular exertion. As the saturation of the hæmoglobin with carbon monoxide gets higher the symptoms rapidly become serious. With 50 per cent. saturation, giddiness, weakness and inco-ordination of muscular movement, failure of mental power, and diminution of acuity of vision and hearing are pronounced; slight muscular exertion causes palpitation of the heart and undue breathlessness, and will probably result in partial or complete loss of consciousness for a time. Such a degree of saturation must therefore be regarded as definitely disabling, but, so far as is known, it will not prove fatal. If the affected person is removed to pure air the mass influence of the oxygen will gradually expel the carbon monoxide from the blood, and the more urgent symptoms will subside fairly rapidly, though nausea, severe headache, and malaise may persist for many hours. With still higher saturations complete paralysis and unconsciousness will supervene, and the end may come with a painless death from sheer failure of the oxygen supply to the tissues of the body.

The minimum concentration of carbon monoxide that will prove fatal is not known with certainty, but the available evidence points to the conclusion that death will ensue after an exposure for several hours to air containing 0·2 per cent. of the gas. Much depends on the length of time that the blood has been highly saturated with carbon monoxide, for the longer grave shortage of oxygen is maintained the more serious is the damage to the tissues of the body, particularly to the nervous system, and the more difficult is recovery. Bearing this in mind it is not improbable that 0·15 per cent. of carbon monoxide in the air breathed might prove dangerous to life in the case of prolonged exposures.

Exposure to relatively high concentrations of the gas leads, of course, to rapid loss of consciousness and death, but in accidental cases of poisoning the concentration of carbon monoxide is, as a rule, comparatively low, and in these circumstances the onset of symptoms will be gradual though progressive, for the gas owing to its low concentration will diffuse but slowly into the blood and it will be long before complete gaseous equilibrium can be established between the blood and the air in the lungs. Herein lies a great danger, for so insidious is the onset of the symptoms that the person affected may not realise that anything is amiss until he has lost so much power in his limbs as to render it impossible to withdraw from the danger. With 0·1 per cent. of carbon monoxide in the air breathed a resting person will become disabled in about two hours and a half, with 0·2 per cent. in little more than a hour, and with 0·4 per cent. in about half an hour. The acceleration of the respiration and circulation by muscular exercise will greatly hasten the rate at which carbon monoxide is absorbed into the blood.

At present there is no legal limitation of the amount of carbon monoxide that may be supplied in ordinary illuminating gas. The Departmental Committee on the Manufacture and Use of Water Gas, 1899, recommended that the Board of Trade should have the power to limit the proportion of carbon monoxide in illuminating gas to 12 per cent. or such higher value as should be considered safe. This recommendation was not, however, made statutory. The Departmental Committee on Carbon Monoxide, 1921, reported "that it is not necessary or desirable to prescribe any limitations of the proportion of carbon monoxide which may be supplied in gas used for domestic purposes," though a suggestion was considered that a limit of 20 per cent. of carbon monoxide might be imposed. Pure coal gas contains 6-8 per cent. of carbon monoxide, water gas contains about 40 per cent., and carburetted water gas about 30 per cent. Water gas is often added for economic reasons to pure coal gas, and the illuminating gas supplied to the public not infrequently contains a quite considerable proportion of carbon monoxide. Occasionally so much as 50 per cent. of water gas has been mixed with the coal gas, with the result that the illuminating gas has contained 20 per cent., or slightly more, of carbon monoxide. As a rule, however, the proportion of water gas is considerably lower than this, and some companies still continue to supply pure coal gas.

An escape of gas is likely to be noticed and quickly remedied during the daytime, but far greater danger arises at night when a person may fall asleep in an ill-ventilated bedroom without noticing that the tap of a gas jet has been accidentally left turned on, or disregarding as trivial an escape of gas from some faulty fitting. He may then be disabled before he has any warning of the danger, and when once disabled he may not be found till many hours have elapsed and it is too late to save him. From the experimental data recorded by Dr. J. S. Haldane in the report of the Water Gas Committee it is possible to calculate the concentration of carbon monoxide which will finally be attained in a room if there is a leak of gas into it, making the assumption that the carbon monoxide becomes uniformly mixed with the air. Even in the most unfavourable circumstances, when there are no special openings to admit of ventilation, there is always a considerable interchange of air through the walls, roof, and floor of any room. Even if the outside air is quite still a volume of fresh air equal to the cubic contents of the room will gain admission in 1·8 hours in a room of 500 cubic feet, in 2·3 hours in one of 1000 cubic feet, and in 2·9 hours in one of 2000 cubic feet, and these rates may be doubled if a strong wind is blowing or if the room is furnished with a fireplace the chimney of which is not blocked. Taking the most unfavourable case the following table shows what will happen in three different-sized rooms if there is a leakage of gas into these rooms at the rates respectively of 4 and 10 cubic feet per hour:

Capacity of room in cubic feet.	Carbon monoxide percentage eventually reached in the room when the illuminating gas contains the following percentages of carbon monoxide.				
	A. Leak of 4 Cubic Feet per Hour.				
	5%.	10%.	15%.	20%.	30%.
500 . .	0·07	0·14	0·22	0·29	0·43
1000 . .	0·05	0·09	0·14	0·18	0·28
2000 . .	0·03	0·06	0·09	0·12	0·17
	B. Leak of 10 Cubic Feet per Hour.				
	5%.	10%.	15%.	20%.	30%.
500 . .	0·18	0·36	0·54	0·72	1·04
1000 . .	0·12	0·23	0·34	0·46	0·69
2000 . .	0·07	0·15	0·22	0·29	0·43

The dotted lines mark the division into fatal and non-fatal percentages of carbon monoxide on the assumption that a concentration of 0·2 per cent. of carbon monoxide may prove fatal if maintained for several hours.

On testing the rate of escape of gas from an unlit gas-jet when the tap was turned on fully, four different burners chosen at random gave the following results. Under a gas pressure of 4 inches of water a properly regulated universal type of incandescent burner with inverted mantle passed about 4 cubic feet of gas per hour, and a Bijou burner of the same type about half that quantity. Under pressures of 1½ and 3 inches of water a No. 3 Bray flat flame burner passed about 6 cubic feet and 9 cubic feet per hour, respectively, and a No. 5 Bray burner about 8 and 11 cubic feet. Under the most adverse conditions, therefore, the risk of fatal poisoning would appear not to be very great in the case of escape from a single well-regulated incandescent burner so long as the proportion of carbon monoxide in the illuminating gas does not exceed 20 per cent., save in rooms of very small cubic capacity, though temporary severe symptoms might be caused. The real danger evidently lies in a leakage of gas considerably greater than that which might be obtained from such a burner. The pressure under which gas is supplied differs very greatly in different localities (under the Gas Regulation Act a minimum pressure of 2 inches water gauge has now to be maintained in the gas mains during the night), and an ordinary flat flame burner through which the rate of escape of gas will vary roughly as the square root of the pressure may clearly become a source of considerable danger if the tap should be accidentally turned full on. Some flat flame burners of improved type allow, however, much less gas to escape than the figures given above. Still greater risk attaches naturally to the grosser forms of leakage from unlit gas-rings, fractured pipes, accidentally disconnected unions and the like, provided that the escaping gas becomes sufficiently mixed with the air in the room. The Water Gas Committee found that with a large escape of coal gas the gas might collect mainly at the top of the room, and if the air in the room remained undisturbed it might be long before feeble convection currents could establish a fatal atmosphere at the level of a bed, but the case is, of course, quite different when the gas is rich in carbon monoxide.

It must be remembered that the table above intentionally depicts the most disadvantageous conditions for the occupant of the room. The majority of bedrooms possess a fireplace, and windows and doors often do not shut very tightly. The natural ventilation in a room might easily be double that on which the table is based without any special provision for ventilation, and the figures shown would then be halved. Under such conditions it would probably require a leak into a room of 1000 cubic feet capacity of 10 cubic feet per hour of gas containing 15 per cent.

of carbon monoxide to establish in the end a really dangerous atmosphere. That the risk in any case is bound to become far greater as the proportion of carbon monoxide in the illuminating gas is increased is evident. In the U.S.A., where much greater concentrations of water gas are used than in this country —indeed pure carburetted water gas is often supplied —the death rate from both accidental and suicidal gas poisoning appears to be far higher than in England. An article in a recent number of the *American Gas Association Monthly* conveys the impression that the gas companies are fully alive to the dangerous qualities of the gas that they distribute, for one of the New York Companies is stated to maintain in each of the districts it supplies a motor van with three crews working in eight-hour shifts ready to do ordinary repairs, and to proceed at any hour of the day or night when a case of gas poisoning is reported, not only to rectify the fault but also to resuscitate the victim of carbon monoxide if he can be reached in time, the crews having been specially trained for this purpose.

It is no use belittling the risks incurred by increasing the proportion of carbon monoxide in illuminating gas, but they should not be unduly exaggerated. It is evidently a case for striking a reasonable balance between the risk and the economic advantages of cheap light and heat for domestic purposes. The risk of accidental poisoning is greater the smaller the room in which an escape of gas occurs. The steady improvement in the housing of the poorer classes, the general use of more economical burners, such as incandescent burners, and the more widespread knowledge of the fact that illuminating gas does have poisonous properties undoubtedly justify a higher limit to be set to the concentration of carbon monoxide permissible in illuminating gas than was contemplated by the Water Gas Committee in 1899, but it may very reasonably be questioned whether the recommendation of the Carbon Monoxide Committee in 1921, that no limitation at all should be imposed by statute, is really justifiable. The report of the latter committee is certainly a most unconvincing document.

Imperial College of Science and Technology.

Opening of the New Botany Building (Plant Technology).

The Imperial College of Science and Technology was founded to give advanced training not only in pure science but also in science in relation to industry. The close association of pure and applied science is exemplified in all the departments of the College, and under the direction of Prof. J. B. Farmer the botany department has been not the least conspicuous in the development of pure botany and of the various branches of applied botany which may be grouped together as plant technology. The department has for a number of years specialised in training men as economic botanists, and particularly for work in the great plantation industries of the tropics, such as rubber, cotton, sugar, etc. Ravages of disease caused by fungal and insect pests, and by other injurious agencies not yet so clearly defined, are particularly severe in these tropical industries, and without the control that science can supply their prosperity would be slight. A considerable proportion of the officers who are engaged in combating disease in tropical plantations have received their scientific training at the Imperial College.

By the rapid expansion of the work of the department in the direction of plant physiology, plant pathology, bacteriology, biochemistry, and plant technology generally, the accommodation provided by the present botany building became quite inadequate, though it was opened only so recently as 1914. Accordingly, an appeal for contributions towards the cost of an additional building was made to the members of the Rubber Growers' Association by Mr. Herbert Wright, an old student of the department and now chairman of the executive committee of the governing body of the College. Thanks to Mr. Wright's untiring zeal and energy and to his personal generosity, the magnificent sum of 30,000*l.* was raised.

Fig. 1.—New botany (plant technology) building, Imperial College of Science and Technology.

The new building was designed by Sir Aston Webb, and is a substantial and well-planned structure of five floors. The basement and ground floors are allocated to biochemistry, and the first floor to the bacteriological side of plant pathology. The biochemical department is well fitted for modern work in biochemistry and includes, besides a laboratory for ordinary class instruction, a large and lofty general laboratory, a number of special research laboratories and private rooms, a laboratory for physical work, a balance room, and a machine room with grinding mills, presses, vacuum distillation apparatus, etc. The bacteriological laboratories are not only fitted for cultural work in microbiology, but also for chemical work in relation to fermentation by yeasts, moulds, and bacteria. On the first floor there is also to be a permanent rubber museum dealing especially with the diseases to which Hevea is subject.

The new building was opened on the afternoon of February 16. The ceremony was performed by the Duke of Devonshire, Secretary of State for the Colonies, Lord Buckmaster (chairman of the governing body) being in the chair. Mr. Herbert Wright, in an introductory speech, explained that the development of the department was due to the foresight and genius of Prof. Farmer, who many years ago realised how much could be done for the development of tropical industry by men with a proper training in such branches of botany as plant pathology and plant physiology. The response to the appeal to the Rubber Growers' Association was so encouraging because the members knew that the College had year after year trained men qualified to advise on vital problems relating to parasitic fungi, insect pests, and other problems of importance to tropical estates. The past pupils of the botanical department were scattered everywhere in the tropical regions of the Empire.

FIG. 2.—New botany (plant technology) buildings, Imperial College of Science and Technology. Main biochemical laboratory.

Prof. Farmer gave a brief survey of the work of the department, and stated that the number of students had increased from 78 in 1914–15 to 137 in 1922–23, a very large proportion of these being research students. This increase, together with the development of such branches of plant technology as biochemistry and bacteriology, had made urgent the further accommodation which the new building now provided. In the scientific education of plant technologists for tropical regions no attempt was made to give such men any detailed knowledge of tropical agriculture; that could only be satisfactorily done on the rubber estate, the sugar plantation, etc., What was aimed at was a thorough grounding in the fundamental sciences on which plant technology was based.

The Duke of Devonshire said that it gave him much pleasure to come to the College and open the new botany building. He well recognised the importance of tropical agriculture. In tropical Africa alone the area of the British dependencies was many millions of acres, with a population of thirty millions, practically all of whom were dependent on agriculture, which was, however, at present but imperfectly developed. Nothing could more surely contribute to the advancement of such dependencies than the application of science to the many problems of agricultural development. The Colonial Office, in establishing the Imperial Bureau of Entomology and that of Mycology, in founding the Imperial Department of Agriculture for the West Indies, and more recently the College of Tropical Agriculture in Trinidad, had shown a realisation of the importance of science in its application to the problems of the development of the agricultural resources of the Colonies.

A vote of thanks to the Duke of Devonshire was proposed by Sir Frank Swettenham (chairman of the Rubber Growers' Association) and was seconded by Sir Arthur Dyke Acland.

In connexion with the opening ceremony a large number of experiments and preparations illustrative of plant physiology and pathology were on view. One set of exhibits, which will form a permanent series, was arranged to show the diseases to which the rubber plantations are liable. It contained many large specimens which have been procured by skilled men and shipped direct from the plantations. It is safe to say that it forms the most complete exhibition of its kind that has ever been seen in Europe, and there is no doubt that it will be of considerable service to the new department for teaching purposes. Characteristic specimens of the obscure and much-dreaded disease, brown bast of rubber, were also displayed. The methods of investigating diseases were illustrated, and a large series of cultures of bacteria, fungi, and yeasts were on view.

A number of exhibits of physiological apparatus were also to be seen. These took the form mainly of instruments which recorded automatically (usually by an electrical device) the rate of some important vital process of the plant, such as growth, transpiration, change in the size of the pores (stomata) of the leaf, and so on. An apparatus for enriching with carbon dioxide at constant partial pressure the air supplied to growing plants was also included.

Obituary.

DR. C. P. GOERZ.

DR. CARL PAUL GOERZ, the founder of the well-known optical and instrument-making firm of C. P. Goerz, died at his home in the Grünewald, Berlin, on January 14, at the age of sixty-nine years. The record of his life is a remarkable one of industry and perseverance successfully exercised in the creation of a great establishment for the production of scientific apparatus of precision.

Although Dr. Goerz, to whom the honour of Doctor Ing. *honoris causa* was accorded by the Technical High School of Charlottenburg, had received no special academic scientific training, he realised the vital need for the exercise of scientific knowledge and research in such work as that to which he was devoted. His success is attributable to his commercial capacity, to his power of appreciating the value of the leaven of science in industry, and to his ability to utilise and encourage the efforts of those with whom he associated himself.

Towards the end of 1886 Dr. Goerz commenced business in Berlin as a small retailer of mathematical instruments, and later of photographic apparatus. In 1887 he engaged his first employee, the number of whom increased to many thousands during the recent war. The present firm dates nominally from 1888, when a small and simply equipped workshop was established in Berlin for the manufacture principally of photographic cameras. For the optical computation of the objectives he was fortunate in engaging the services of Carl Moser, who died in 1892.

Further progress resulted from the association of Paul Goerz with Ottomar Anschütz, whose pioneer work in the instantaneous photography of animal action had attracted much public attention. But the greatest advance in the fortunes of the firm is attributable to the introduction of the Goerz double anastigmat, designed by a casual applicant for scientific employment, Emil von Höegh.

Thereafter the progress was rapid. The present headquarters and well-equipped workshops were commenced in 1894. Numerous branches were established in foreign countries, and during the war a large mass-production factory was erected in the suburb of Zehlendorf. A separate works was devoted to the production of photographic film and kindred chemical work.

Realising the need for unrestricted supplies of optical glass, Dr. Goerz established on ground adjacent to his mass-production works at Zehlendorf the Sendlinger optical glass works, the origin of which can be traced through the laboratories of Steinheil at Sendlinger near Munich to the original glass works of Fraunhofer.

Dr. Goerz is survived by his second wife and by a daughter and two sons, the children of his first wife who died in 1897.

Through his death the German optical industry has lost a vigorous leader of striking personality, respected by all who were associated with him, and particularly by his many employees, in whose welfare he always exercised an active interest.

J. W. F.

THE HON. R. C. PARSONS.

READERS of NATURE will have learned with regret of the death of the Hon. Richard Clere Parsons in London on January 26, in his seventy-second year. After a brilliant career at Trinity College, Dublin, where Mr. Parsons graduated in honours at twenty-two years of age, he was apprenticed to Messrs. Easton and Anderson, and it was during this period that his love of hydraulics developed and became the dominant factor in his life's work. In January 1875 he was asked by Mr. Anderson to make experiments upon centrifugal pumps, and the work culminated in the reading of a paper, entitled "The Theory of Centrifugal Pumps as supported by Experiments," before the Institution of Civil Engineers —a paper which gained him the Miller Prize. This was his first-fruits, and in his later work, both scientific and practical, he continued to be principally concerned with water-flow. Mr. Parsons read many other papers before the Institution, from which he received the Telford gold medal, the Manby premium, and the George Stephenson medal. His first important post was that of resident engineer of the South Hants Water Works; in 1880 he became a partner in the firm of Messrs. Kitson and Co., Leeds; seven years later he entered into partnership with the late J. F. La Trobe Bateman, F.R.S., and so commenced the consulting practice which he continued until his death.

Much of Mr. Parsons's work was carried out abroad; for example, the water supply and drainage of the city of Buenos Ayres, and the scheme which he prepared for the drainage of Petrograd. He held many important consultative appointments, and it was while acting in the capacity of engineer for the Water Works Company of Rosario that his inventive faculty exerted itself in producing an apparatus for automatically adding a coagulant to a water supply before filtration. To this he gave the name Tiltometer. It was followed by another invention called the Senfrot, for adding salt to water when under pressure.

Perhaps Mr. Parsons's most important invention was the Stereophagus pump introduced by him in 1911, and used for the pumping of sewage or water containing solid matter. In this, use is made of revolving blades, which cut up any solids, and thus prevent the possibility of choking. The description of this pump, and also of another, known as the Flexala, which was designed for dealing with fluids containing erosive substances, was given in a paper read before the Institution of Civil Engineers in 1919 entitled "Centrifugal Pumps for dealing with Liquids containing Solid, Fibrous or Erosive Matters."

Mention should be made of the interest which Mr. Parsons took in educational work. During his stay in Leeds he was connected with the development of the Yorkshire College, now the University of Leeds, and he was for thirty-three years connected with King's College, London, of which he was treasurer and vice-chairman. He was also, on the nomination of the University of London, a governor of the Imperial College of Science and Technology, and was a vice-president and manager of the Royal Institution.

MR. W. M. HUTCHINGS.

THE death of a well-known metallurgist, Mr. William Maynard Hutchings, occurred at Harrogate, at seventy-three years of age, on January 17. Mr. Hutchings' school-days were spent at a Moravian school on the Rhine, and he received his technical training in metallurgy and mining at Leipzig and Freiberg. After leaving the University he opened an assay office in Liverpool. Later he spent some years at the lead smelting works at Petrusola in Italy, and after a short period in South Wales became manager of Walker Parker and Co.'s Deebank Lead Works at Bagillt, North Wales, where he replaced the older Pattinsonian process by the then comparatively new Parkes process. In 1889 Mr. Hutchings joined the firm of Messrs. Cookson and Co., Ltd., at Newcastle, as their chief metallurgist and technical manager. In conjunction with the late Mr. Norman Cookson, he designed and installed a large Parkes desilverising plant, which was at the time a model of efficiency. He also introduced for them the first chamber white lead works in this country, which he operated with great success. He retired from active duties in 1915, but held a consulting post with this firm till the time of his death.

Throughout his busy life Mr. Hutchings found time to carry out investigations in other branches of science, and his numerous and lengthy papers on the petrology of shales, clays, and slates published in the *Geological Magazine* created great interest, and are evidence of his active mind and patient capacity for research. He also contributed frequently to several scientific periodicals, and at one time contributed a regular column to *Engineering*. He was an original fellow of the Institute of Chemistry and some time member of the Society of Chemical Industry.

Mr. Hutchings was essentially a strong man, thorough in all his work, a distinguished metallurgist, and a fearless advocate of his own convictions. He was of a retiring disposition, but a lover of Nature, and a notable characteristic was his intense love of animals.

WE regret to announce the following deaths:

Rev. J. C. P. Aldous, author of "An Elementary Course of Physics," and formerly chief naval instructor of the cadets in H.M.S. *Britannia*, on February 18, aged seventy-three.

Prof. E. E. Barnard, professor of practical astronomy in the University of Chicago, on February 6, aged sixty-five.

Prof. J. W. Caldwell, emeritus professor of chemistry in Tulane University of Louisiana, on January 2, aged eighty.

Dr. J. A. Elliott, professor of plant pathology in the University of Arkansas and pathologist in the Arkansas Agricultural Experiment Station, on January 18.

Dr. James Gow, formerly headmaster of Westminster School and author of "A Short History of Greek Mathematics," on February 16, aged sixty-nine.

Prof. S. Günther, emeritus professor of geography in the Technical High School of Munich.

Prof. S. S. Keller, head of the department of mathematics of the Carnegie Institute of Technology, on January 12.

Mr. F. J. Lloyd, agricultural chemist, for many years connected agricultural and dairy societies, on February 8, aged seventy.

Dr. F. Neesen, professor of physics in the Military Technical Academy of Berlin, and known for his work on the determination of trajectories by a photographic method, aged seventy-three.

Prof. W. N. Parker, emeritus professor of zoology at the University College of South Wales and Monmouthshire, Cardiff, on February 22, aged sixty-five.

Dr. Terano, director of the Aeronautical Research Institute in connexion with Tokyo Imperial University and formerly professor of naval architecture in the Engineering College of that University, on January 8, aged fifty-four.

Current Topics and Events.

THE council of the Royal Society has recommended for election into the society this year the following fifteen from the list of candidates:—Dr. E. D. Adrian, Dr. W. Lawrence Balls, Prof. Archibald Barr, Prof. C. H. Desch, Prof. E. Fawcett, Prof. F. Horton, Dr. R. T. Leiper, Prof. J. W. McBain, Prof. J. J. Rickard MacLeod, Dr. G. A. K. Marshall, Sir Douglas Mawson, Dr. W. H. Mills, Dr. J. S. Plaskett, Prof. H. R. Procter, and Prof. W. Wilson.

THE official opening of the new research laboratories of the General Electric Co., Ltd., at Wembley on February 27 was an interesting event. It is probable that this is much the largest industrial research laboratory erected by any firm in this country. The buildings have a total floor space of more than 80,000 sq. ft., and the tour planned out for visitors, comprising a passage through all the laboratories and workshops, involves a walk of something like three miles. There is a well-equipped library, and an organised system of abstracting and recording papers for reference has been devised. Throughout the building, pipes carrying gas, compressed air, a vacuum service, etc., have been installed, the taps being painted in distinctive colours. A feature is the arrangement whereby pipes and electric cables traverse a gallery at the top of the building so that none are carried under the floor, the outlets descending from the ceilings. In addition to the large number of rooms devoted to different sections of research work, there are wood and metal workshops, and a small experimental factory where new types of lamps can be made and tested on a small scale, so as to eliminate all manufacturing difficulties before manufacture in bulk is attempted. In these days, when demand for economy plays such an important part in the programmes of manufacturing concerns, it is interesting to note this enterprising departure, which will doubtless be well repaid.

A CONSIDERABLE amount of attention has been devoted in the daily Press to a paper dealing with various alleged dangers to eyesight of electric light, read by Mr. A. E. Bawtree before the Royal Photographic Society on February 13. One of the points raised, the high intrinsic brilliancy of filaments, has a certain degree of justification, and various members of the Illuminating Engineering Society who were present at the discussion agreed that electric lamps, in common with other modern illuminants, require proper shading. The effects of ultra-violet light have been thoroughly studied, but it is now generally agreed that the possibility of injury to eyesight being caused by the small proportion of such radiation present in incandescent lamps is remote. Certainly the matter does not deserve to be regarded with alarm. Moreover, photographers should be well aware that the amount of ultra-violet light in natural light is considerably greater than that in most artificial illuminants. Of other problematical dangers such as "X-ray, electron, and undiscovered emanations," the author could present no confirmatory evidence and they were not regarded with any concern by the audience, the speakers dissenting from most of his suggestions. The matter is of interest as furnishing one of those cases in which alarmist statements are indiscreetly published in the daily Press, and relatively small difficulties, easily overcome by reasonable care, are magnified. A little prior consultation with experts in such cases would enable editors to avoid giving publicity to unconfirmed statements which are liable to cause misapprehension on the part of the public.

Among the resolutions adopted by the council of the American Association for the Advancement of Science at the December meeting at Cambridge, Massachusetts, is one referring to recent attempts in various parts of the United States to prohibit the teaching of evolution as applied to man. The council asserts its position and that of the Association with its 11,000 members clearly and emphatically in the following resolution : "(1) The council of the association affirms that, so far as the scientific evidences of the evolution of plants and animals and man are concerned, there is no ground whatever for the assertion that these evidences constitute a 'mere guess.' No scientific generalisation is more strongly supported by thoroughly tested evidences than is that of organic evolution. (2) The council of the association affirms that the evidences in favour of the evolution of man are sufficient to convince every scientist of note in the world, and that these evidences are increasing in number and importance every year. (3) The council of the association also affirms that the theory of evolution is one of the most potent of the great influences for good that have thus far entered into human experience ; it has promoted the progress of knowledge, it has fostered unprejudiced inquiry, and it has served as an invaluable aid in humanity's search for truth in many fields. (4) The council of the association is convinced that any legislation attempting to limit the teaching of any scientific doctrine so well established and so widely accepted by specialists as is the doctrine of evolution would be a profound mistake, which could not fail to injure and retard the advancement of knowledge and of human welfare by denying the freedom of teaching and inquiry which is essential to all progress."

The association of Sir Christopher Wren with the Old Ashmolean building at Oxford, to which Mr. R. T. Gunther directs attention in a letter published in our correspondence columns, is of particular interest at the present time, on account of the celebration of the bicentenary of Wren's death. Mr. Gunther's suggestion, that the upper rooms of the building should be used as a science museum, has received the support of practically all the leading members of scientific departments of the University, as well as of others. If this proposal is approved, it is hoped that the valuable collection of old astronomical and other scientific instruments offered by Mr. Lewis Evans to the University will be housed in the Old Ashmolean building, which, should Mr. Gunther's views be correct, will thus be restored to its ancient purpose.

H.R.H. The Prince of Wales has accepted the presidency of the Empire Forestry Association, and is presiding at the Association's annual meeting at the Guildhall at 3 p.m. on March 2. At this meeting the new council of the Association will be elected, consisting of 45 members—9 for the United Kingdom, 10 for the Dominions, 2 for India, 6 for the Crown Colonies and Dependencies, and 18 for affiliated societies—nine of these representing Overseas associations. The Prince of Wales is proposing the adoption of the report of the Empire Forestry Association, which has made remarkable progress since it was formed as an outcome of the post-war Imperial Forestry Conference. The Association is promoting a permanent exhibition of Empire commercial timbers in London, and will play an important part with regard to the timber section at the British Empire Exhibition in 1924.

A special exhibit of abnormal growths taken from trunks, branches, and roots of trees and shrubs has been arranged in Museum IV. at Kew Gardens. The specimens include burrs, witches' brooms, deformed leaves, contorted stems, fasciated shoots, deformed roots, and other items. In some instances the deformity is due to injury at an early period of the plant's life ; in others (as in fasciation) it may be caused by luscious growth, while deformed leaves may sometimes be a reversion to a former type. Witches' brooms are usually caused by irritation set up by fungus or insects. They are very common on birch, but occur on many kinds of trees. Burrs on trunks may follow a blow on the bark or the punctures of insects. Burrs are often very large, and the wood is prettily marked. It is in demand for furniture and cabinet work, and often commands a high price. Curved trunks (as in the pine stems exhibited) are brought about by the tunnelling of the larvæ of a small moth. Irregular annual rings are often caused by a tree being fully exposed to sun and air on one side and crowded on the other. Roots are often deformed by growing in gravel beds or between the bricks of walls, whilst the development of aerial roots on trees and shrubs may be due to an injury or to excessive moisture.

An address on "Biological Contributions to Sociology," delivered by Prof. J. Arthur Thomson before the Sociological Society on February 20, Prof. G. Elliot Smith in the chair, raised a number of questions of wide interest. Knowledge of what may be termed the natural history of man is closely related to the study of social activities and changes, and it should be used to promote the healthy growth of civilised society. Among biological subjects which have a direct bearing upon this development are heredity and environmental influence, variation as the raw material of possible evolution, the relation of individuation and reproduction, population problems, the results of inbreeding and outbreeding in man, the selective influence of disease, and the preservation of the physically unfit in civilised life. As regards the physical characteristics of man, natural selection has ceased to operate in modern society, and the weak and morally or mentally deficient are encouraged to live at the expense of the strong. Society itself will eventually have to decide whether it will continue to promote the reproduction of the unfit or adopt measures of artificial selection with the object of eliminating them. Man can be the master of his own destiny, and is not altogether the creature of circumstances, as are other natural species. The race ought, therefore, to look to scientific guidance for human growth not only towards individual fitness but also towards a higher human perfection.

At the Royal Asiatic Society on February 13, Mr. E. J. Holmyard delivered a lecture on Arabian alchemy and chemistry, in the course of which attention was directed to the large amount of material available in manuscript form in the libraries of Europe, especially Constantinople, and in Cairo. Mr. Holmyard also expressed the view that it was probable that the laboratory note-books of the chemists of Islam might prove, if they could be found, of at least equal importance with their more famous books. The question of Geber was considered, and some lantern slides, showing typical forms of apparatus, were exhibited. In the discussion which followed, Prof. E. G. Browne laid stress on the need for a thorough and adequate study of the development of chemistry in Islam. Dr. C. Singer disagreed with the lecturer's statement that the Arab chemists kept their chemistry free from astrology, and said that a belief in astrology was a normal part of the mental equipment of all educated men in the Middle Ages. Mr. Robert Steele showed the connexion between Arab chemistry and medieval European chemistry, and Prof. J. R. Partington brought forward further evidence in favour of Mr. Holmyard's views that Berthelot's arguments against the identity of Geber and Jābir ibn Ḥaiyān were unsound. Dr. Gaster pointed out the importance of Berthelot's work on the Greek alchemists, and Mr. H. S. Redgrove suggested that it was rash to assume that the mystical alchemical verse of Khālid ibn Yazīd had no practical meaning.

The annual general meeting of the Institution of Heating and Ventilating Engineers was held on February 6, and Mr. John Watson was elected president for the year. In his presidential address he stated that they might be proud of the progress of the Institution, in membership and influence, during the twenty-five years of its existence. Several Government departments have representatives on the Institution's committees, showing that its influence is extending. Referring to the education of the engineer, Mr. Watson considered that the facilities now offered are much in advance of anything previously available. At the age of 21 or 22 years, any intelligent youth who has followed the prescribed 6-years course suggested in "Advice to Intending Students" would be well informed in general knowledge of elementary engineering science, and in the basic facts of heating and ventilation. Mr. Watson also referred to some technical matters. The question of super-power stations for the supply of cheap motive power had been discussed by the district heating committee in conjunction with a committee of the Institution of Electrical Engineers. The use of condensing engines in existing stations led to an enormous amount of heat being carried away in the condensing water, whereas by using some of these stations as combined heating and power stations, and utilising the exhaust steam for heating and hot water supply to buildings in the vicinity, something like 50 per cent. of the heat content of the fuel would be realised in useful work, instead of perhaps 12 per cent.

Dr. W. H. Maw, president of the Institution of Civil Engineers and past-president of the Institution of Mechanical Engineers and of the Royal Astronomical Society, has been awarded the Bessemer gold medal of the Iron and Steel Institute. The medal was founded by Sir Henry Bessemer in 1873, and is awarded annually to any member or non-member of the Institute who may be (1) the inventor or introducer of any important or remarkable invention, either in the mechanical or chemical processes employed in the manufacture of iron or steel; (2) for a paper read before the Institute, and having special merit and importance in connexion with the iron and steel manufacture; (3) for a contribution to the Journal of the Institute, being an original investigation bearing on the iron and steel manufacture, and capable of being productive of valuable practical results. The medal may also be awarded for work not coming strictly under the foregoing definitions, should it be considered that the iron or steel trades have been or may be substantially benefited thereby. A diploma accompanies the award of the medal, in which it is formally stated that the award is "for eminent services in the advancement of metallurgical knowledge," or, alternatively, "for eminent service in the advancement of the application of iron and steel."

A dinner to celebrate the twenty-fifth anniversary of the foundation of the Röntgen Society will be held on Thursday, March 15, at the Hotel Cecil, Strand, London, W.C.

The annual meeting of the Royal Society for the Protection of Birds will be held at the Middlesex Guildhall, Westminster, S.W., on Wednesday, March 7.

MAJOR-GENERAL SIR WILLIAM B. LEISHMAN has been appointed Director-General, Army Medical Service, in succession to Lieut.-General Sir T. H. J. C. Goodwin.

THE degree of doctor of laws *honoris causa* has been conferred on Sir Frederic Kenyon, director and principal librarian of the British Museum since 1909, by Princeton University, New Jersey.

AT the Bristol Museum, according to the report for the year ending September 30, 1922, Mr. F. G. Pearcey has built up in an exhibition case the representation of a living coral reef. "A collection of typical reef corals has been covered with a thin gelatine layer, coloured as true to the living coral as possible, and arranged in natural fashion upon a modelled sea-floor, together with crustacea, mollusca, sea-urchins, and fishes." It sounds simple, but needs in the artist that knowledge of actual reef conditions which Mr. Pearcey possesses, thanks to his voyages in the *Challenger* and other exploring ships.

AMONG the books to be published during the spring and summer this year by the Clarendon Press and the Oxford University Press are: Vol. 5 of the translation of Suess's "The Face of the Earth," being the index of subjects and of persons and places; "The British Coal-mining Industry during the War," Sir R. A. S. Redmayne, comprising chapters on the pre-control period—1915–16, the period of government control—1917–18, de-control—1919–21, general survey of the coal-mining industry of the United Kingdom during the period 1914–21 and appendixes; "The Legacy of Rome," edited by C. Bailey, with the following contributions: Religion and Philosophy, C. Bailey, Family and Social Life, H. Last, Literature, J. W. Mackail, Language, H. Bradley, The Science of Law, F. de Zulueta, The Conception of Empire, E. Barker, Roman Architecture and Art, G. McN. Rushforth, Science, Dr. C. Singer, Administration, H. Stuart-Jones, Communications and Commerce, G. H. Stevenson, Agriculture, W. E. Heitland, and Engineering, G. Giovannoni; "Makers of Science," I. B. Hart, in which an attempt is made to present a survey of the broader movements in the history of the physical and mathematical sciences from Greek days to the present time.

Our Astronomical Column.

PARTIAL ECLIPSE OF THE MOON.—A partial eclipse of the moon will occur during the morning hours of March 3, and may be well observed if the atmosphere proves favourable. The moon will enter the denser shadow of the earth at $2^h\ 28^m$ A.M., the middle of the eclipse will be at $3^h\ 32^m$ A.M., and our satellite will emerge from the shadow at $4^h\ 36^m$ A.M. The fainter shade or penumbra will also involve the moon between $1^h\ 13^m$ A.M. and $5^h\ 51^m$ A.M. The northern or upper region of the disc will be obscured, and if we regard the whole surface as equal to 1·0 the proportion eclipsed will amount to 0·38, or nearly two-fifths. This eclipse is a return of that of February 19, 1905, when the magnitude was about three-tenths.

The cycle of recurrences in eclipses is equal to 18 years and 11 days and was discovered by the Chaldæans, who named it the Saros. It enabled the ancients to foretell the return of these phenomena with tolerable accuracy.

THE ATMOSPHERE OF VENUS.—Mention has been made in this column (May 6, 1922, p. 592) of the result obtained by Prof. St. John and Mr. G. B. Nicholson, at Mt. Wilson, demonstrating the absence of the lines of water-vapour and oxygen in the spectrum of Venus. A paper by them in *Astrophys. Journ.*, December 1922, gives full details of the investigation, with beautiful reprints of the spectra, which are arranged to make the Doppler displacement of the solar lines in the spectrum of Venus clearly visible, while it is absent for the water-vapour band, showing its telluric origin. It is stated that the spectra confirm Prof. Slipher's result that fifteen days seem to be an inferior limit for the period of rotation of Venus.

A review is given of former results. Vogel, Scheiner, and Arrhenius all concluded that water-vapour is present on Venus from the apparent strengthening of its spectral bands; but obviously the use of the Doppler principle with a high dispersion is far more decisive. It is concluded that the quantity of oxygen in the atmosphere of Venus can scarcely exceed a thousandth of that in our own, or it would have been detected.

The authors quote the suggestion of Arrhenius that the oxygen in our atmosphere may have resulted from plant life, so that if Venus had no organisms on it oxygen would not be present in its atmosphere. Proceeding to speculate on the conditions on the planet, they consider that the slow rotation would be likely to cause violent air circulation, owing to the great difference of temperature between the day and night hemispheres. It is supposed that the rotation, though slow, is not so slow as to put one hemisphere in perpetual night. The absence of water would make the ground very dusty, and high winds would raise dense clouds of it. It is suggested that this is the nature of the Venus clouds. According to Prof. Russell their albedo is less than that of our clouds. It is suggested that direct photographs through violet and infra-red filters, as used by Prof. R. W. Wood on Jupiter and Saturn, would give information about these clouds, and might even reveal the surface below in regions where they were thin.

THE RADIAL MOTIONS OF STARS OF TYPE N.—This type (Secchi's Type IV.) consists of red stars with carbon bands. Lick Observatory Bulletin No. 342 contains a study of the velocities of twenty-five of these stars in the line of sight by J. H. Moore. Twenty-three of these stars have well-determined proper motions, and a correlation of these with the radial velocities enables the mean parallax of the group to be determined. Three different methods of treating the data give the closely accordant values of the latter 0·0032″, 0·0028″, 0·0031″. The mean apparent magnitude of these stars at maximum is 6·1, which implies a mean absolute magnitude of −1·5, in good agreement with the value −1·3 found by Luplau-Janssen and Haarh from the proper motions alone. This gives confidence in the result.

It appears that these stars are giants, in an early stage of their career as stars. Till the Giant and Dwarf Theory obtained currency, the red variable stars were generally looked on as expiring suns, and compared to a candle flickering in its socket before extinction, but this new research combines with many others to show that this view is incorrect.

Research Items.

Psychology in Engineering.—In his Sidney Ball memorial lecture (Scientific Management and the Engineering Situation, Barnett House Papers, No. 7, Oxford University Press, 1922. Price 1s.), Sir William Ashley discusses the much debated problem of scientific management, with special reference to the engineering trade. He reviews its beginning in America, its development there, and the interest aroused in it in this country. He points out that, as it has arisen in the engineering trade, it bears the marks of people accustomed to think in terms of the exactly measurable, engineering being largely a matter of exact formulæ. Unfortunately for the mechanist, the human being is quite frequently influenced by motives which defy exact measurement. Aiming at increasing output and thereby diminishing the cost for each unit of work, it was attempted by time and motion study and a bonus system to settle the problem of wages. It has, however, introduced more complications to an already complicated problem, and just where it leaves the domain of mechanics to enter that of psychology, it breaks down. English psychologists criticise the so-called scientific management, not because it calls itself scientific, but because it is not sufficiently scientific. The application of science to industry is valuable, but it is not scientific to apply the principles of one science to problems belonging to another of a quite different order.

Fleas and Plague in India.—One of the most striking features of the prevalence of plague in India is the relative immunity of Madras compared with, for example, Bombay or the Punjab. The Advisory Committee for Plague Investigation examined the problem at length, but failed to find any satisfactory explanation. It was believed at that time that the prevalent rat flea all over India was *Xenopsylla cheopis*. Rothschild, however, afterwards found that under that identification three very closely allied species—*X. cheopis*, *X. astia*, and *X. brasiliensis*—had been confused, and Hirst pointed out that the distribution of plague in India and Ceylon corresponded well with the hypothesis that the real *X. cheopis* was alone an effective transmitter of the disease. He now reports (*Indian Journal of Medical Research*, vol. x., 1923, p. 789) a full series of experiments confirming his earlier work, and showing that *X. astia*, the prevalent rat flea in Madras, will carry plague from one animal to another only with much more difficulty than *X. cheopis*, the rat flea of Bombay. Details of plague epidemics in Colombo, where plague has never become widely spread and where the fleas are mostly *X. astia*, with a few *X. cheopis*, bear out his thesis in a striking manner. It seems as if a considerable advance has been made in the epidemiology of plague which illustrates the fundamental importance of systematic zoology in these problems.

Effects of the Contiguity of Organisms.—In a series of experiments on the influence of density of population on longevity in the fly Drosophila, R. Pearl and S. L. Parker show (*American Journal of Hygiene*, vol. iii., 1923, p. 94) that the optimal density for duration of life is not the minimal density The mean duration of life increases with increase of density of population up to a certain point, and afterwards, as would be expected, declines. Thus, starting with about 2 flies per ounce bottle the average life is 28 days, which increases rather rapidly to about 40 days with 50 flies per bottle, declines again to 28 with a density of about 90, and to 17 and 13 with densities of 150 and 200. This favouring effect of organisms on one another recalls the observations of T. B. Robertson (*Biochemical Journal*, vol. xv., 1921, p. 612), who found that the rate of asexual multiplication of the infusorian Enchelys was much greater if the culture contained two individuals to start with than if only one was present. It is too familiar to most bacteriologists that the dispersion of a few bacteria in a large volume of culture liquid will often fail to give a successful growth which is obtained with certainty if the same number of organisms is sown in a small quantity of medium. All this suggests a general proposition that contiguity to like individuals is, up to a certain point, favourable to the life of organisms.

Cork Formation.—In a continuation of the useful physiological studies in plant anatomy carried out at the University of Leeds, Prof. J. H. Priestley and Miss L. M. Woffenden (*New Phytol.*, vol. 21, No. 5) have made a study of the causal factors in cork formation. A causal sequence can be traced both in the formation of wound cork and leaf scars, as well as in the natural internal origin of a cork layer. A parenchyma surface is first blocked by suberin deposits in presence of air. This is followed by the accumulation of sap at the blocked surface, and this in turn gives rise to the development of a phellogen or cork cambium in the area involved. In the absence of air, a meristematic zone may be artificially produced without the formation of cork in the cell walls.

Growth and Maturation of the Sugar Cane.—Dr. Kuyper has described the physiology of sugar formation, and the methods used in Java to harvest the canefields at the exact moment of highest maturity in "The Formation of Sugar and the Ripening in Sugar Cane" (Suikervorming en ryping by het suikerriet), Archief voor de Suiker-industrie in Nederlandsch Indië, 1922, 2e deel blz. 195-321, Mededeelingen No. 5. Cultivation is so directed that the fullest use is made of the available light, and in this connexion the author discusses the questions of the optimum distance between the plants and rows, the effect of tying up the canes as a preventive against lodging, the influence of yellow stripe disease upon sugar production, and the relation between cellulose formation and sugar content. In Java the process of ripening of sugar cane is carefully watched by means of analyses of samples taken regularly every two or three weeks. The course of maturity can be judged by the relation between total solids and the quotient of purity (Brix and RQ) in the different parts of the stalk; the glucose ratio changes in a way which is the reverse of that seen in the percentage of available sugar. It has been proved that the time of planting and the age of the cane have much influence upon the maturation process, as if climatic conditions are favourable the sugar content of fields of different ages may reach almost the same final percentage, whereas under unfavourable conditions the late planted canes will not be so rich in sugar. Maturing is found to progress most regularly in places in which the rainfall is very low during the milling season, but where the soil contains sufficient moisture to prevent the cane from dying without permitting further growth to occur.

Oceanography of the Southern Ocean.—A note by Commander F. A. Worsley in the *Geographical*

Journal for February gives some account of the hydrographical work of the *Quest* expedition. Thirty-two soundings were taken in the Southern Ocean. The first series was from a point 500 miles east of the South Sandwich Group to about lat. 60° 45′ S., long. 4° E., and then to lat. 69° 18′ S., long. 17° 11′ E. The position and details of the soundings are not given, but it would appear that water of practically 3000 fathoms was crossed in the supposed "deep" in the Biscoe Sea. Shoaling water towards the south, practically where Bellingshausen made his southern attempt in 1820, confirmed that navigator's belief in the occurrence of land not far off. A depth of 1089 fathoms might occur within 50 miles of the Antarctic continent. From this point an irregular line of soundings was carried westward across the mouth of the Weddell Sea towards Elephant Island. These confirmed the discoveries of the *Scotia* and *Deutschland*, which showed the Weddell Sea to be approximately 2500 fathoms in depth. No soundings were taken between Elephant Island and South Georgia, and only three were taken between South Georgia and Tristan da Cunha. None appears to have been taken in the uncharted waters to the east of the South Sandwich group. It is most unfortunate that heavy weather prevented oceanographical work exactly in those areas where the gaps in knowledge are widest. A search for a reported reef 350 miles E. by N. of Tristan da Cunha showed that it does not exist. The paper also contains a new map of Gough Island and some additional surveys in South Georgia.

OIL EXPLORATION IN NEW SOUTH WALES.—The Federal Government of Australia recently offered a reward of 50,000*l*. for the discovery of commercial deposits of petroleum within the continent, in order to encourage private enterprise in prospecting. Not content with this, the New South Wales Government has made a further offer of 10,000*l*. for the discovery and production of 100,000 gallons of natural mineral oil within the State, and so that such enterprise, if undertaken, should be carried out with at least a technical chance of success, a blue-book has been prepared by the Geological Survey of that State, which discusses petroleum and natural gas and the possibilities of their location within its confines. The publication is a credit to all concerned, but more particularly to its author, Mr. Leo J. Jones, who, writing primarily for the non-technical public, has set forth the principles of oil production in a commendably lucid manner. By following the text of the first five chapters of the pamphlet carefully, no ultimate failure can be set down to ignorance, and the "wild-catter," if unsuccessful, can reasonably plead ill-luck. The two concluding chapters review past operations for locating oil-pools in New South Wales and discuss the possible areas awaiting exploration. A complete stratigraphical succession for the State is quoted, and forms the basis of a brief survey of the oil potentialities of each formation. In the summary, however, we are acquainted with the official opinion regarding future oil possibilities, two extracts from which read as follows: "The prospects of obtaining commercial supplies of oil in New South Wales are by no means bright . . .," and again ". . . New South Wales will have to depend for its oil supplies, not upon deposits of crude petroleum, but upon the mining and distillation of oil shales . . ." already known to occur extensively in the state; with which observations we are in entire agreement. It would thus seem that the New South Wales Government is reasonably safe in offering the reward quoted, and, for that matter, the Federal Government is probably in a similar position.

METEOROLOGY IN MYSORE.—The twenty-ninth annual report for 1921 and a separate report on rainfall registration in Mysore for 1921, prepared under the direction of Mr. N. Venkatesa Iyengar, meteorological reporter, have recently been published by the Mysore Government. The annual report contains data for the four observatories, Bangalore, Mysore, Hassan, and Chitaldrug. Monthly means for the several elements are compared systematically with the respective normals for 29 years. Annual means of temperature at the four observatories differed by rather more than 4° F., Bangalore being the coldest with 69·2° F. and Chitaldrug the warmest with 73·6° F. Rainfall for the year was greatest, 36·62 in., at Bangalore, which is 1·43 in. more than the normal, the least, 24·37 in., at Chitaldrug, which is 0·50 in. less than the normal. According to the report on rainfall registration, rain is measured at 226 stations, the mean for the State being 36·19 in. against an average of 36·10 in. The greatest rainfall in 24 hours was 14·00 in. at Agumbi in the Shamoga District on July 30. The two heaviest falls of rain in 24 hours during 1921 are given for each of the rainfall stations. Percentage of the rainfall is given for each season in each district and for the State as a whole. For the State in the cold weather period, January and February, the percentage of the normal was 238; in the hot weather period, March to May, it was 3 per cent. deficient; in the south-west monsoon period, June to September, it was 5 per cent. deficient; and in the north-east monsoon, October to December, it was 11 per cent. in excess. The rainfall is given for the several river basins, and the departure from the normal. The detailed results are of considerable value to the world's meteorology.

CONCENTRATION OF MINERALS BY MULTIPHASE MAGNETS.—The problem of the utilisation of multiphase currents for the separation of minerals from ore continues to be developed by Mr. W. M. Mordey. An important paper on the subject, which he read in December 1921 before the South African Institution of Electrical Engineers, was dealt with in an article by Prof. Truscott, of the Royal School of Mines, in NATURE of April 29 last year. Experiments illustrating the physics of the method were shown last summer at the conversaziones of the Royal Society, and were repeated with some extensions on the occasion of the Silvanus Thompson Memorial Lecture at Finsbury Technical College on February 1. Meanwhile, in the Bessemer Laboratory of the Royal School of Mines the process is assuming a character approaching practical requirements. A stream of "pulp," consisting of crushed mineral in water, is passed down a launder, under which is placed a multiphase magnet. The magnetic field causes the mineral constituents to move gradually to one side of the stream, leaving the gangue on the other side. In this test the material principally made use of is an ore of Norwegian specular hæmatite, a crystalline oxide of iron, which, being almost *non-magnetic*, is not amenable to treatment by ordinary magnetic separators. Under the influence of the multiphase magnet, the particles of this material can be seen moving steadily across the stream, from one side of the launder to the other, in a way that will be understood by those who have witnessed these experiments with dry materials. The test has also been carried out with an ore of magnetite. This powerfully *magnetic* material is, for the most part, held stationary over the poles of the multiphase magnet; but when the field is reduced in strength, its action resembles that of specular hæmatite, *i.e.* the concentrate forms on one side of the stream, and the gangue is washed down on the other.

The Unit Activity of Animal Organs.

ONE of the most remarkable features of the animal body is the fact that each organ has more substance than is necessary to do its normal amount of work. Teleologically it is easy to see that some such arrangement is necessary for successful survival, but it is more difficult to imagine the mechanism by which it is kept in working order. If a muscle is used less it grows smaller, and if it is used more it grows larger. In each case it preserves the margin of power which is known as "reserve force," despite the definite general relation between quantity of substance and quantity of function. In a recent number of the *Journal of Pathology and Bacteriology* (vol. xxv. p. 414) Dr. V. R. Khanolkar makes some interesting speculations and observations which seem to throw light on the problem, and he extends them into suggestions which may clear up some obscure points in respect of the distribution of pathological lesions in organs. So long ago as 1871 Bowditch formulated the proposition that if the frog's heart responds at all to an artificial stimulus it responds with the greatest contraction of which the muscle is at the time capable. This principle of "all or nothing" has since been extended to other excitable tissues, most convincingly to muscle and nerve, and by implication to glands which receive their normal stimuli through the nervous system. On this basis, moderate activity of a skeletal muscle means maximal activity of a moderate number of the units, in this case muscle fibres, of which it is made up and not moderate activity of all the units.

In other words, in ordinary circumstances only a proportion of the units of any organ are active at any one time. How then do the other units escape the consequences of the rule that tissue which is not used atrophies and disappears? Marey in 1885 found that the responsivity of the frog's heart to external stimuli is least when it is actually contracting and is only gradually restored to normal after the contraction is over. Each period of activity is thus followed by a "refractory period" in which the tissue will not respond to a strength of stimulus which would normally rouse it to activity, the resistance to excitation fading away until the normal excitability is regained. This refractory phase has been closely studied in nerve muscle and sense organs, and Gotch described it as a general phenomenon of living substance. In this way a rotation of activity among the units of any organ is brought about: with moderate activity in response to moderate stimulation a proportion of the units are constantly in action, but as the refractory period of each one comes on it stops working and its function is taken on by another unit with its activity more remote and its refractory period completed. As the activity of the whole organ is increased owing to stronger stimulation, the refractoriness of units is broken through first in those the activity of which is remote, next in those which have functioned more recently. Finally, with maximal stimulation all the units are forced into simultaneous action.

It seems likely that these principles, elucidated by the classical method of "wiring frogs on to machinery," are applicable to other tissues in which their demonstration is more difficult. What constitute anatomical "units" is not known. In nerve and muscle they are the individual fibres, in the central nervous system probably nerve cells, in the kidney possibly the glomerular-tubal systems, in glands apparently groups of adjacent cells—but they might be parts of organs, cells, or even parts of cells. Dr. Khanolkar has specially concerned himself with the kidney, and supposing that each glomerulus with its efferent tubule is a unit, points out that the hypothesis would explain the irregular distribution of the lesions in the common chronic degeneration of that organ. Assuming that the original injury is due to some poison circulating in the blood, it follows that more of it will reach active than passive units since activity is always associated with a local increase in blood supply. On general grounds also it is quite likely that functioning cells are more reactive and hence more easily poisoned than cells at rest. In chronic general nephritis some glomeruli are destroyed while others appear to escape injury altogether, and the diseased and healthy units are found scattered uniformly all over the organ. It is suggested that the injured units are those which happened to be active when a toxic concentration of the poison was in the blood. Extending the idea to other organs, it follows that activity always renders a tissue more susceptible to poisonous substances, which may be the explanation of why the parts of the nervous system most constantly in heavy use are specially liable to suffer in general lead poisoning and other similar relations. Failure of an organ from over use might in part be due to this, in part to the absence of rest for any of the units. It is well recognised that hypertrophy of skeletal muscle is best secured by exercises which seem absurdly mild: on the hypothesis of unit activity it is easy to understand why light dumb-bells should keep more units in the best possible condition than heavy ones.

Dr. Khanolkar adduces experimental evidence that in the kidney during moderate activity only some of the glomeruli are in action, while more or all will excrete actively when the organ is strongly stimulated with diuretics. Incidental observations on the adrenal medulla, pituitary, pancreas, and salivary glands give histological evidence of the same partial activity. The whole fits in well with Krogh's recent demonstration that many capillaries in normal organs are at any one moment closed and out of action.

Climates of the Past.

W. R. ECKARDT, of Essen, has contributed a memoir, "Paläoklimatologie, ihre Methoden und ihre Andwendung auf die Paläobiologie," to Prof. Abderhalden's comprehensive "Handbuch der biologischen Arbeitsmethoden" (Urban und Schwarzenberg, Berlin), of which it forms Heft 3 of Abteilung 10. It is written in what may be called the *über Alles* type of German, without much consideration for the southerner or the stranger, and sentences containing more than 100 words are not uncommon. It embodies, however, a valuable and critical review of the way in which various classes of geological evidence may be used as indications of the climatic environment of the faunas and floras of the past.

The character and colour of fossil soils are discussed by Dr. Eckardt, equally with the distribution of fossil organisms. It is pointed out that areas of bogland (*Sumpfflachmoor*) and peat may arise even in tropical conditions, moisture and low-lying land being the real necessities, and Wegener is cited as regarding all the great coal-basins as formed in a zone of equatorial rains. The important question of annual rings in wood, discussed recently in Deecke's "Paläophytologie" (see NATURE, September 16, p. 375), receives careful consideration, and the author concludes that these rings cannot be used by themselves as elucidating climatic conditions. Dr. Eckardt supports the view that seasonal changes of temperature have been felt in polar regions even when the climate was warmer over the whole earth; but at certain periods mild subpolar winters have been associated with summers much hotter than those of the present day.

A. Handlirsch is interestingly quoted as showing how the length of the anterior wing in insects may be used as an indication of prevalent temperature, since it increases at the present day from an average of 7 mm. in central Europe to 16 mm. in the tropics. The length in Lower and Middle Carboniferous strata in our latitudes is as much as 51 mm., but decreases in Upper Carboniferous and Permian times to 20 or to 17 mm. Little that bears on his subject has escaped Dr. Eckardt, and the correlation of scattered scientific observations, in the hope of solving problems, is aptly illustrated in his concluding sentence, where he quotes Eckholm as showing that great importance must be attached to the obliquity of the ecliptic in explaining the post-Glacial distribution of the hazelnut in Scandinavia.

Dr. Eckardt points out that at the present day the relative distribution of land and water has an influence on climate only about a third or a quarter as important as that of latitude. Prof. E. W. Berry, however, in a paper on a possible explanation of Upper Eocene climates (Proc. Amer. Phil. Soc., vol. 61, p. 1, 1922), urges that a prevalence of low-lying land as against mountain areas, and an enlargement of oceanic areas, allowing of free circulation from broad equatorial basins to the poles, was a sufficing cause of the warmer, though still zonal, conditions revealed by Eocene vegetable remains. The Upper Eocene hazel, for example, came no farther south in Eocene times than lat. 45°, because the Atlantic basin resembled in breadth that of the present Pacific Ocean. The author even looks back to the views of Lyell, and suggests that "the distribution and altitude of the land and sea" may have accounted for the glacial epochs.

A. Brockmann-Jerosch, who is much quoted by Dr. Eckardt, has recently suggested that glacial conditions in Switzerland were favoured by an oceanic climate and a copious rainfall ("Die Vegetation des Diluviums in der Schweiz," Conférences de la Soc. Helvétique des Sci. nat., 1920, p. 73). Perhaps the proximity of the mountains in this area removed one of the factors relied on by Berry. There is clearly much philosophical discussion still before us in palæoclimatology.

G. A. J. C.

Studies on Phytophthoras.

In the *Mededeelingen v. d. Landbouwhoogeschool*, Wageningen, xxiv., No. 4, 1922, Miss de Bruyn publishes (in English with a Dutch summary) a paper entitled "The saprophytic life of Phytophthora in the soil." After reviewing the literature pertaining to fourteen species of the genus in relation to the question of their capacity for life as saprophytes in the soil, Miss de Bruyn describes her own work on the cultivation of the three species, *P. Syringæ*, *P. erythroseptica* and *P. infestans*, in soils of different types. Most of the experiments were carried out with soil which had previously been sterilised, and details of the growth in this medium are given in each case.

The general conclusion reached is that Phytophthoras are not such obligate parasites as was formerly supposed, and it is claimed that the experiments carried out prove that each of the species mentioned can actually live and grow in the soil. Cultures on sterilised soil as well as on other media were exposed out of doors to rather severe frost for several days, and it was found that *P. Syringæ* and *P. erythroseptica* survived such treatment. So far as the cultures in soil are concerned, however, it would appear that such survival may have been due to the presence of oospores. In the case of *P. infestans* (the oospores of which are still unknown in Nature) the results of exposure to similar conditions were not concordant, and the question as to whether this species can overwinter in the soil is regarded as unsolved. It was found, however, that when growing on sterile raw potato slices, *P. infestans* survived a temperature of $-9°$ C., although at this low temperature the potato slices themselves were blackened.

Attempts were made to cultivate *P. Syringæ* and *P. erythroseptica* in non-sterilised soil, but the results do not appear to have been very satisfactory. It seems clear that further and more critical work will have to be carried out before it can be accepted as convincingly established that these two fungi are really capable of sustained growth and development in ordinary soil. No information is given as to whether *P. infestans* was found to live and grow in ordinary unsterilised soil; and speculation as to whether the survival of this fungus in the soil from season to season may account for primary outbreaks of potato blight seems therefore altogether premature.

Another recent contribution to our knowledge of this fungus is contained in a doctorate thesis presented to the University of Utrecht by Miss M. P. Löhnis, entitled "Onderzoek over *Phytophthora infestans* (Mont.) de By. op de aardappelplant." (Wageningen, H. Veenman, 1922.) An account of pure culture work with various media is given; immature oogonia and oospores were found twice in cultures on raw potato and Quaker Oat agar.

Experiments on the manner in which infection of the potato occurs are described, and in discussing the question of the propagation of the blight from season to season it is recorded that on five occasions a diseased tuber was found before any infection of the foliage was apparent. It is suggested that the fungus may perhaps subsist in the soil, but this point is not yet regarded as definitely established. Other matters dealt with are the influence of the stage of development of the plant on its susceptibility to infection, the mode of entry into the tubers and growth of the fungus in the subterranean parts of the plant, the formation of wound cork and varietal resistance to blight. The thesis is provided with a summary in English, and a more detailed abstract of it will be found in the *Review of Applied Mycology*, I. 8. Aug. 1922, p. 253.

Aeronautical Research Committee.

The report of the Aeronautical Research Committee for the year 1921–22 (H.M. Stationery Office, 1922, 2s. 6*d.*) consists of two parts. The first—the report proper—gives a formal résumé of the activities of the committee, and of its sub-committees on air-inventions, aerodynamics, engines, materials and chemistry, meteorology, accidents, fire prevention, and load factors. A feature of great interest in this report is the reference to the loss of the Airship R38 and of the valuable lives thus cut short. The committee deprecates the tendency to make development in aircraft depend upon the investigation of accidents, and advocates strongly the method of systematic research directed to each element of the design. It asserts the necessity of employing the highly trained and skilled researchers that are now available for the scientific study of aeroplane and airship development, and on the question of finance counters the "axe" enthusiasts as follows: "The money which would have come to this country had R38 been a success would have maintained the research of the Committee in full activity for a period of five years. In another way it may be stated that, should the work of the Committee lead to a reduction by one of the aeroplanes written off per year as a result of crashes, it would have earned the cost to the Air Ministry of the fees paid to its members." This is a sufficiently cutting condemnation of so-called "economy," but one wonders how much effect it will produce in official circles.

The second part of the report consists of a supplement, giving in some detail an account of the researches that have been and are being conducted, with indications of their scope and results. In aerodynamics the chief topics studied have been control at low speeds, the general theory of aeroplane flight (investigated by Prof. G. H. Bryan), aerofoils, the circulation and vortex theory of Prandtl, etc. On internal-combustion engines work was done on trustworthiness, sparking-plugs, fuels, etc., while it is of interest to read that a beginning is being made (at Cambridge University and at Armstrong College, Newcastle) to bring University workers into contact with Government aircraft research. The meteorological work dealt with the structure of the atmosphere and the formation of cyclones and fog, and with instruments, etc.

The part of the supplements dealing with accidents will naturally attract much notice. The accident to the Tarrant Triplane "Tabor" led to the discovery of inadequacy in the rudder control, and to the development of relay controls for dealing with the longitudinal control plane. Airship R36 suffered accidents which showed the necessity for experimental work on an actual airship. In the case of the R38 the disaster was due to structural weakness in the design. No calculations had been made of the stresses caused by aerodynamical forces and movements, although such stresses may exceed considerably those due to weight and buoyancy. While it appears that model data would, indeed, have been sufficient to indicate the kinds of stresses that would be obtained in flight manœuvres, the committee emphasises the importance of full-scale work.

It is not possible here to mention all the numerous items of aeronautical research referred to in the report. Suffice it to add that, at a ridiculously small cost to the nation, work is being done that will add as much to our national security and commercial prosperity as the many millions we spend so thoughtlessly in response to popular clamour.

The Hydrautomat.

The problem of raising a small quantity of water to a considerable height by utilising the energy of a larger mass of water has been solved in a number of ways. In the seventeenth century, the City of London was supplied with water pumped from the Thames by means of a reciprocating pump, driven by a crank which was made to rotate by a water-wheel turned by the flow of the river. The "hydraulic ram" is a device that has been successfully used, and recently there has been developed a device, the hydrautomat, which utilises the pressure of the atmosphere to lift water (Allen Hydrostatic Pump Syndicate, Ltd., 110 Victoria Street, S.W.1).

Let it be supposed that there is a source of supply at a height of H feet above a tail race. For example, water might be led along a channel constructed by the side of a falling stream, the slope of the channel being less than that of the stream, to some point at which there is a difference of level H feet between the water surface in the channel and the river. At a height H/2 from the river bed is constructed a closed tank which is connected to the supply channel by means of a siphon pipe entering the closed tank at the bottom, and to the bottom of the tank is connected another siphon which has a rising limb and a discharging limb taken down to the river bed. To the top of the closed tank is connected an air-pipe which has connexions to a series of closed tanks placed at various heights, on a hillside, say. Each of these closed tanks has a siphon pipe led from the bottom of the closed tank to the top of an open tank at a higher level. From the top tank of all the water can be taken to any desired point.

Let now the water be allowed to flow from the channel into the lowest closed tank, entering at the bottom. The air in this tank will be compressed and will be conveyed under pressure along the rising pipe, and to each of the closed tanks above, from which the water is raised to the open tanks above. When the pressure in the lowest tank reaches a certain value, the discharging siphon automatically operates. The escaping water acts upon a flat vane, which is connected to a lever controlling a valve which cuts off the supply from the channel to the lowest tank, and a partial vacuum is produced in the closed tanks. Water is thus drawn from any one of the open tanks to the closed tank immediately above it. There is thus an alternate delivery and suction stroke for each lift of $\frac{1}{2}$H. The only valve is that between the channel and the lowest tank. The device is an exceedingly interesting and simple one, and the plant required is inexpensive in first cost and upkeep. A plant is working at Carshalton, Surrey.

University and Educational Intelligence.

Bristol.—A tablet bearing the names of all members of the University who fell in the war is shortly to be placed in the new University buildings. The war memorial committee is very anxious to guard against omissions, and will be grateful if relatives of the fallen who have not already communicated particulars will inform the secretary of the committee accordingly.

Cambridge.—The offer of the Ministry of Agriculture to found a professorship of animal pathology with funds from the Development Commissioners has been accepted. The Council of the Senate has published recommendations as to the duties and emoluments of the professorship, and if these are approved the election to the new chair need not be long delayed.

LEEDS.—At a meeting of the Council on February 21, Prof. Smithells was reappointed to the office of Pro-Vice-Chancellor.

Mr. James Robb has been appointed district lecturer in agriculture.

It has been decided to reinstitute a formerly existing professorship of therapeutics in the department of medicine, and to elect Dr. W. H. Maxwell Telling to this chair.

LONDON.—The Senate has made a grant of 75*l.* from the Publication Fund to the Rev. F. J. Wyeth in aid of the publication by the Royal Society of his D.Sc. thesis entitled "The Development of the Auditory Apparatus and Associated Structures in *Sphenodon Punctatus.*"

The Senate has adopted a resolution recording with great regret the resignation of Dr. M. J. M. Hill of the Astor chair of pure mathematics at University College, which he has occupied since 1884.

The Academic Council has prepared a table showing the universities from which, up to the present, applications have been received for registration as Internal Students for the Ph.D. degree. The classified totals are as follows:—

Great Britain (London 171) and Ireland	255
Europe	10
Australia and New Zealand	16
United States of America	30
India	62
South Africa	3
Canada	8
Japan	1
	385

The degree of D.Sc. (*Engineering*) has been conferred upon Mr. A. E. Clayton for a thesis entitled "Papers on Alternating Current Machinery" and other papers.

The council of Bedford College for Women invites applications from women for a post-graduate scholarship in sociology, value 150*l.*, for one year. Further information is obtainable from the Secretary of the College, Regent's Park, N.W.1.

MANCHESTER.—The Council has approved a scheme for the establishment of a Colloids Research Laboratory in the University. A sum of 11,842*l.* has been subscribed and given to the University towards the endowment and cost of the equipment of the department. Mr. D. C. Henry, at present a lecturer in chemistry, has been appointed lecturer in colloid physics and will take charge of the Laboratory, which will be known as "The Graham Research Laboratory." The Council has expressed its hearty appreciation of the gift to the various subscribers, and especially to Dr. Kenneth Lee, who has been largely responsible for the scheme.

Mr. Norman B. Maurice has been recommended for the degree of Ph.D., his thesis being "On the Unsaponifiable Constituents of Commercial Rosins."

OXFORD.—The Edward Chapman Research prize of Magdalen College is to be offered for competition at the beginning of the summer term this year for a published piece of original research in one of the following departments of natural science: physics or chemistry, including astronomy, meteorology, mineralogy, geology, or the biological sciences of zoology and botany, whether treated from the morphological, palæontological, physiological, or pathological point of view. The prize is of the value of 20*l.* and restricted to members of Magdalen. Further particulars are obtainable from Mr. R. T. Gunther, Magdalen College. Competing essays must reach him not later than May 1.

THREE fellowships, tenable for two years, each of the annual value of 200*l.*, are being offered by the University of Wales to graduates of that university. Applications must be received before June 1 next by the Registrar, University Registry, Cathays Park, Cardiff, from whom further information may be obtained.

NOTICE is given that the tenth election to Beit fellowships for scientific research will take place on or before July 16 next, and that the latest date for the receipt of applications is April 19. Forms of application and all information may be obtained from the Rector, Imperial College, South Kensington, S.W.7, upon written request.

A LECTURE on the work and aims of the newly-established West Indian Agricultural College, Trinidad, will be given at Vernon House, Park Place, St. James Street, S.W., at 8 P.M., on Monday, March 5, by Mr. W. R. Dunlop, of the Imperial Department of Agriculture, who has taken an active part in the organisation of the College. The chairman at the lecture will be Dr. A. W. Hill, director of the Royal Botanic Gardens, Kew.

THE next meeting of the Imperial Education Conference is to be held in London at the end of June of this year. The last meeting was held in London in 1911, and but for the war the Conference would have met in 1915. The Conference will be attended by official representatives from the Education Departments of the Self-governing Dominions and Colonies and the British Isles, and various matters of common interest will be discussed, including the question of the interchange of teachers within the Empire.

THE third report of the British Association Committee on Training in Citizenship, presented at the Hull meeting in September last, has recently been issued and is obtainable from the secretary of the committee, Lady Shaw, 10 Moreton Gardens, S.W.5. The greater part of the report is devoted to an appendix containing a bibliography of books on civics. About 12 pages are occupied by this list, which mentions altogether about 400 books, pamphlets, and magazine articles. It was found impossible and undesirable to include all books bearing on the subject; there can be no doubt, however, that any serious student with this list in hand could rapidly make himself familiar with the various aspects of civics and the different points of view apparent in the treatment of the subject. As is natural, only publications of the last few years are, in general, mentioned. One suggestion, of special interest to readers of NATURE perhaps, occurs after a study of the report: What would an anthropologist say to this vast literature of citizenship? He would, we judge, divide it into two classes: first, those writings in which citizenship is looked at as the natural course of life in a human community, and in relation to the essentially simple occupations on which all human life is based; and, second, those in which chief place is given to current, and often unscientific, views of human life and organisation. The choice between those two types of book would be of importance not only in connexion with citizenship, but also in connexion with science-teaching.

THE jubilee of the University Extension movement will be celebrated this year at Cambridge, where it began under the leadership of Prof. James Stuart, of

Trinity College, in 1873. Delegates from all the universities of the Empire and many of those of the United States, as well as representatives of local lecture centres and tutorial classes and local education authorities, will be invited to attend a conference, to be opened on July 6 by Lord Balfour as Chancellor of the University, which will last until July 10. The annual summer meeting will be held at Oxford on July 27, when Sir Michael Sadler will deliver the inaugural lecture of a course on "Universities and their Place in National Life." The list of lecturers will include Prof. Clement Webb, Dr. Selbie, Canon Ollard, Principal Ernest Barker, Dr. Cranage, Dr. L. P. Jacks, Mr. Ramsay Muir, Sir Gregory Foster, Principal Childs, Mr. J. A. R. Marriott, Mr. Albert Mansbridge, Mr. J. R. M. Butler, and Miss Maude Royden, and probably Dean Rashdall, Prof. Rait, and Mr. Coulton. The subsidiary subject of study at the meeting will be "The Social and Economic Problems of English Country Life," introduced by Sir Daniel Hall. The following statistics are taken from annual reports for 1921–22 on University Extension work of the Universities of Oxford, Cambridge, and London, the figures for the several universities being given in the above order: number of courses, 121, 92, 144; enrolment, 12,000, 11,721, 12,431. Summer vacation courses are being organised this year by or in connexion with almost all the English universities, the University of Wales, and the University of Aberdeen. Holiday courses for foreigners will be provided at Cambridge and London.

THE results of a comprehensive investigation of the home-residence of university students in 1920–21, undertaken by the United States Bureau of Education, have been tabulated in Bulletin, 1922, No. 18. On an average, one-fourth of the students in the universities and colleges of a State came from outside the State and 1½ per cent. came from foreign countries. Of these 6900 foreigners, Asia contributed 2506, North America 2156, Europe 1379, South America 563, Africa 223, Australia 61, China 1443, Canada 1294, Japan 525, West Indies 396, Russia 291, Mexico 282, India 235, Central America 184, France 160, Great Britain 149, South Africa 141, Brazil 126, Norway 94. From United States possessions (chiefly the Philippines, Hawaii, and Porto Rico) there were 1456 students. The returns published by the University Grants Committee for the same year show that of full-time students in universities and university colleges in Great Britain in receipt of treasury grant (but excluding Oxford, Cambridge, Guy's Hospital Medical School, and Trinity College, Dublin), 42 per cent. came from places beyond 30 miles from the institution, 6·2 per cent. from beyond the United Kingdom, and 1·7 per cent. from foreign countries. Turning to the Universities Yearbook, 1922, we find the percentage of students from outside the United Kingdom was 8, the difference being due to including returns from Oxford, Cambridge, Dublin, and Guy's: Asia contributed 1576, America 781, Europe 645, Africa 1187, the Pacific 281, China 143, Canada 200, Japan 73, West Indies 101, Russia 91, India 1240, France 62, U.S.A. 400, South Africa 832. Similar statistics in the Swiss *Bulletin Universitaire* of November last show that of students attending the seven Swiss universities in 1922, 20 per cent. were foreigners, the proportion being highest in Fribourg, Geneva, and Lausanne; at the Federal Polytechnic, Zurich, the proportion was 16.

IN view of the recent recommendation of the Board of Education's Consultative Committee that more attention should be paid in secondary schools to the cultivation of music and that this subject should be given full recognition in the first and second school certificate examinations, the report recently published by the United States Bureau of Education (Bulletin, 1921, No. 9) on the "Present Status of Music Instruction in Colleges and High Schools" is of interest to teachers and others in this country. It appears that nearly half of the universities and colleges in America allow entrance credit in musical theory and more than one-third in "appreciation," including history, form, and so on. Recognition of applied music for entrance qualification is a matter of very recent development, but already in 1919 more than one-sixth of these institutions allowed entrance credit in piano, violin, etc., and half as many recognised performances in orchestra, glee-clubs, and chorus singing. In 25 per cent. credit for applied music is allowed toward the B.A. or B.Sc. degree. In general it may be said that there is ample evidence of increasing interest in the development of music as a social, cultural, and professional subject in the universities and colleges. The same may be said of the high schools, where orchestra is becoming an increasingly important feature of school life and courses in harmony and appreciation are often provided. The report does not distinguish between boys and girls except as regards glee-singing, of which there appear to be almost as many boys' as girls' courses. The fact that credit toward school leaving certificates is granted in a large proportion of the schools offering music courses seems to indicate that there is an effort to present these courses in a manner sufficiently thorough to make them compare in requirement with the other courses of the high school.

AN American criticism of higher education in Australia and New Zealand has been published by the United States Bureau of Education in Bulletin, 1922, No. 25. It is based on a visit to Australasia in 1920 by Dr. C. F. Thwing, president emeritus of Western Reserve University and author of "Universities of the World" (Macmillan, N.Y., 1911). Among other differences between American and Australian universities Dr. Thwing notes that whereas one half or more of American undergraduates look forward to a business career, most of those in Australia are preparing for the professions and only a very few go into business: most of the engineering graduates enter the Federal Public Works departments. Training for the professions, while thorough in a practical sense, lacks generally the liberal foundation given in the American college. Dr. Thwing, who is interested chiefly in the sociological aspects of university questions, considers that notwithstanding the apparent success of the adult-education movement in the universities, their influence on the community is slight and there is a tendency for their members to confine themselves to their special work and avoid all public responsibility. He believes that in the presentation of many subjects, such as government and economics, teachers are liable to be hampered by the fact that the university depends for grants for its support on a government which is often controlled by doctrinaire leaders of the so-called working classes. Until recent years no chair of economics was established in any university, although education for citizenship should have been one of the principal services of the university to a community in which there is a dearth of men of any great distinction in the political sphere, and parties are generally content with negative cries. While Dr. Thwing was gathering materials for his account of Australasian universities, Prof. E. R. Holme, of Sydney, happened to be similarly engaged in studying higher education in America and preparing his book on "The American University."

Societies and Academies.

London.

Royal Society, February 22.—G. I. **Taylor** and C. F. **Elam**: The distortion of an aluminium crystal during a tensile test (Bakerian lecture). A rectangular specimen 1 × 1 × 20 cm. cut from a round bar of aluminium, which had been treated by the method of Carpenter and Elam, so that it consisted of one single crystal, was stretched through successive extensions of 0, 10, 20, 30, 40, 60, and 78 per cent. of the original length. At each stage of the test, distortion was determined by measurements of scratches ruled on the surface and the directions of the crystal axes were determined by X-ray analysis. The method for determining the nature of the distortion was to find lines of particles which were unextended by the strain. The directions of these lines lie on a quadric cone, which evidently has two positions corresponding with the two configurations from which it was derived. It was found that, up to 40 per cent. elongation, the "unextended cone" was of a degenerate form consisting of two planes, one of which contained in all cases the same particles, while the other contained different particles for different strains. Distortion was due to slipping or shearing over the former plane. By X-ray measurements it was found that the slip plane was identical with an octahedral (III) plane of the crystal. The direction of the shear was along one of the three principal lines of atoms in the octahedral plane. When the specimen was extended beyond 40 per cent. elongation, the effect of the shear was to rotate the axis of the specimen relative to the crystal axes in such a way that another (III) plane came into a position where its inclination to the axis was the same as that of the slip plane. In these circumstances slipping might occur on both planes simultaneously.

Aristotelian Society, February 5.—Prof. A. N. Whitehead, president, in the chair.—May **Sinclair**: Primary and secondary consciousness. Consciousness is defined as a state of awareness, of knowing that there is something "there." Idealism regards the world as arising in consciousness; realism regards it as existing apart from and independent of consciousness. Primary consciousness is all that is present to the subject in perception, contemplation, memory, and immediate thinking, before reflection, judgment, and reasoning has set in. It says nothing about the external and independent existence of its content or object. Secondary consciousness is consciousness of consciousness. It is all reflection, judgment, reasoning, all the play of mind round and about its object. Secondary consciousness is always distinguishable from its object and primary consciousness is not. Therefore secondary consciousness alone supports the realist's assumption and provides the basis for his attack. At the point where consciousness is most vivid, most intense, its identity with its object is absolute: as in the consciousness of a lightning flash, of shell-fire, or toothache. Here there is no possibility of analysing into consciousness and independent object. Yet at this point primary consciousness is the intensest affirmation of its object's existence. There is no reason why this should be so if realism were true. We cannot then distinguish between consciousness and its object. When we seem to be doing this we are really distinguishing between primary and secondary consciousness, and the distinction falls within consciousness. Implicit judgments of perception present a difficulty. They would seem to be primary. But all explicit judgments are clearly secondary. The realist judgment is of this nature and it comes too late to save the independent reality of the object.

Royal Anthropological Institute, February 6.—Mr. H. J. E. Peake in the chair.—E. O. **Rutter**: The natives of British North Borneo. Fifty years ago the native population of North Borneo consisted of pirates, who ranged along the coasts, and of head-hunters, who lived in small communities in the hills. The natives may be divided into three groups—the people of the coast, the people of the plains, and the people of the hills. The coast natives are mainly Bajaus, Sulus, and Illanuns; they are Mohammedans and, for the most part, sea-gipsies. Boats take the place of caravans and they make their living from the produce of the sea. Even when they build houses they are usually constructed over the water upon the seashore or the river banks. Some are accomplished horsemen. The inhabitants of the plains are the Dusuns, a race of farmers, law-abiding and industrious, who cultivate the rice which is their staple food. Some of the Dusuns come into the hill group and with them are the Muruts. The latter are the most primitive race. They live in villages of one or perhaps two houses 200 or 300 feet in length, perched high upon a hill to be out of the way of raiding-parties. Only within the last few years have they abandoned head-hunting, which was the outcome of feuds between villages. Peace terms were sealed by bathing in the blood of buffaloes and planting stones as witnesses of oaths of peace.

Linnean Society, February 15.—Dr. A. Smith Woodward, president, in the chair.—A. M. **Alston**: On the method of oviposition and the egg of the beetle *Lyctus brunneus* Steph.—V. S. **Summerhayes**: Lichens collected by the Oxford University Expedition to Spitsbergen in 1921. In all, 68 species in 27 genera of lichens were found, chiefly on Bear Island, a mass of limestone rock, and Prince Charles's Foreland, of siliceous rock.—F. Howard **Lancum**: Curious oviposition by a specimen of the clouded yellow butterfly, *Colias edusa*. A female *Colias edusa* refused to deposit ova and declined to feed. At the end of a fortnight it was transferred casually to a leaf of a potted plant of white clover, and it laid one egg, and by moving it seventeen times in succession to different leaves, seventeen eggs were obtained. It was curious that it would not deposit an egg until it was moved.—B. Daydon **Jackson**: C. A. Agardh's "Aphorismi botanici," Lundæ, 1817–26, 8°. The volume confirms the practice prevalent in Scandinavia to the middle of the previous century, the Præses being the actual author, and the Respondentes being little better than dummies.

Royal Meteorological Society, February 21.—Dr. C. Chree, president, in the chair.—E. **Gold**: A proposed reform of the calendar by Dr. C. F. Marvin, Chief of the U.S. Weather Bureau. Dr. Marvin in his pamphlet states that the only modification of the Gregorian calendar which meets the need of the meteorologist is one which calendars the year in exactly 13 months of 28 days each, each of which would start on a Sunday. One day in each year and an additional day in leap year, should be set apart as public holidays.—S. **Fujiwhara**: (1) On the growth and decay of vortical systems. Water vortices of a like sense of rotation attract, and vortices of opposite sense repel each other. Vortices grow by amalgamation, and cyclones and anticyclones can be regarded as following similar laws. The equation of growth of energy of vortices is similar to the equation for vital growth given by Brailsford Robertson. (2) On the mechanism of extratropical cyclones. From the equation for change with time of the vorticity of horizontal motion in the earth's atmosphere devised by Hesselberg and Friedmann, the most important source of energy of a cyclone is in the vorticity of the surrounding field. The feeding of a cyclone along the steering surface (of the Polar Front theory) is capable of explanation as the absorption by the main whirl of the horizontal whirl which forms at the surface.

Edinburgh.

Royal Society, February 5.—Prof. F. O. Bower, president, in the chair.—A. G. **Ogilvie**: Physiography of the Moray Firth coast. The coastal features along the Moray Firth from Golspie to Inverness, thence east to Port Gordon, were described. The Firth seems to occupy the site of a foundered crustal block, bounded by known fractures on the north-west, and by possible faults on the south side. Four marine platforms occur there, but the detailed levelling shows that the inland margin of the highest beach is never above ninety feet. Some of the flat expanses of gravel and sand, hitherto regarded as remnants of this terrace, seem to be outwash aprons from the retreating glaciers. Special attention was directed to the constructive action of the sea in originating shingle bars and sand bars, which unite to form forelands and strand plains.

Cambridge.

Philosophical Society, February 5.—Mr. C. T. Heycock, president, in the chair.—E. A. **Milne**: The escape of molecules from an atmosphere, with special reference to the boundary of a gaseous star.—J. E. **Jones**: Free paths in a non-uniform rarefied gas with an application to the escape of molecules from an isothermal atmosphere. In a gas such as exists at the outer fringes of an atmosphere the usual formulæ of the kinetic theory for the calculation of free paths are no longer applicable. The necessary generalisations have been applied to find the condition under which a molecule may escape from an atmosphere. The total number of molecules lost in this way has then been enumerated by a more detailed method than has been used hitherto.—J. S. **Rogers**: L series of tungsten and platinum.—R. H. **Fowler**: Contributions to the theory of α-particle phenomena. Pt. I. Stopping powers. Pt. II. Ionisation.—C. G. F. **James**: The representation of varieties in space of three and four dimensions.—M. J. M. **Hill**: On the fifth book of Euclid's elements.—G. H. **Hardy**: A chapter from the notebook of Mr. Ramanujan.—E. C. **Titchmarsh**: Hankel transforms.—J. P. **Gabbatt**: A generalisation of Feuerbach's theorem.

Paris.

Academy of Sciences, February 5.—M. Albin Haller in the chair.—G. **Bigourdan**: The "Cabinet du Roi" and the forgotten discoveries of Rochon. An historical account of the installation of this observatory in 1761, its equipment and an account of the astronomical work done there by Noël, Leroy, and Rochon.—Charles **Richet**, L. **Garrelon**, and D. **Santenoise**: The laryngo-cardiac reflex.—A. **Blondel**: Influence of the speed governors controlling turbo-alternators on the oscillations of the electrically connected sets. Case of indirect regulation.—R. de **Forcrand**: The hydrates of krypton and argon. The dissociation pressures of these hydrates have been measured at varying temperatures and the heats of formation calculated from the results.—J. **Roudaire-Miégeville**: The grapho-mechanical determinations of systems of real or imaginary solutions of algebraical equations. A development of the work of Kempe and of Koenigs on tracing algebraic curves by an articulated system.—Charles **Fremont**: The cause of the formation of the elongation at constant load near the elastic limit in testing mild steels.—Th. **Moreux**: The probable cause of the anti-solar glow.—A. **Buhl**: The mass and electromagnetic fields of Th. De Donder.—Paul **Dienes**: Tensorial geometry.—J. **Haag**: The distribution of the molecules of a gaseous mass; application to the formula of Van der Waals.—Albert **Pérard**: Study of some neon radiations with the view of their applications to metrology. A comparison of the cadmium line (508·582 $m\mu$) with five neon lines. The ratios of the cadmium and neon lines are not constant. The systematic variation proved that the neon lines were very close doubles.—L. **Bouchet**: Application of the plane-cylinder electrometer to the determination of the inductive capacities of solid substances.—R. de **Mallemann**: Determination of the electromagnetic double refraction of active liquids.—René **Ledrus**: The increase of dispersion in photo-electric X-ray spectra.—St. **Procopiu**: The arc spectra of metals in various media and in a vacuum. The metals studied were copper, gold, zinc, cadmium, magnesium, calcium, and aluminium, and the arcs were produced in air, hydrogen, coal gas, nitrogen, water, and in a vacuum. All the metals gave a stable arc in nitrogen, including magnesium, calcium, and aluminium, with which it is difficult to maintain an arc in air. Stable arcs were also produced in a vacuum. Details are given of the change produced in the lines.—P. **Dejean**: Correlation between the hypothesis of the elementary demagnetising field and the theory of the molecular field.—E. **Darmois** and J. **Périn**: Dextro malic acid and the utilisation of ammonium molybdomalate for the resolution of racemic malic acid. The dextrorotatory malic acid prepared by Walden's method is partially racemised, and it contains about ¾ dextrorotatory acid and ¼ lævorotatory acid. By conversion into ammonium dimolybdomalate a separation can be effected.—G. **Claude**: The application of coke oven gas to the synthesis of ammonia. After removal of benzol by oil and carbon dioxide by lime water, the remaining gases are separated by fractional condensation, the hydrogen passing on to the ammonia apparatus.—Raymond **Delaby**: The characterisation of the alkylglycerols.—Léon **Bertrand** and Antonin **Lanquine**: Extension of the *duplicatures provençales* under the Cheiron layer (Alpes-Maritimes) to the west of the Var valley.—Filippo **Eredia**: The dryness of Italy during the year 1921.—E. and G. **Nicolas**: The influence of hexamethylene-tetramine and formaldehyde on the internal morphology and chemical changes in the bean.—A. **Polack**: The physiological determinism of the accommodative reflex of the eye.—J. **Dragoiu**, F. **Vlès**, and M. **Rose**: Cytological consequences of the lowering of the hydrogen ion concentration on the evolution of the egg of the sea-urchin.—A. **Goris** and P. **Costy**: The urease of fungi. The urease from *Boletus edulis* was studied: detailed accounts of the effects on the enzyme of heat, acids, alkalies, neutral salts, and antiseptics are given.—L. G. **Seurat**: The fauna of penetration of South Tunisian rivers.—R. **Herpin**: The sexual relations in *Perinereis cultrifera*.—L. **Léger** and E. **Hesse**: A fungus of the Ichthyophonus type, a parasite of the intestine of the trout.

SYDNEY.

Royal Society of New South Wales, December 6.—Mr. C. A. Sussmilch, president, in the chair.—Miss Ida **Brown**: Notes on hornblende and bytownite from hypersthene gabbro, Black Bluff, near Broken Hill. A description of the separation of hornblende and plagioclase felspar from a gabbro which occurs about six miles to the south-east of Broken Hill, and a discussion of their chemical composition and optical properties.—H. G. **Smith** and J. **Read**: The glucoside occurring in the timber of the red ash, *Alphitonia excelsa*, Reiss. The red colour of this timber is due to the oxidation, upon exposure to light and air, of a characteristic constituent, which shows a marked resemblance to fustin, the glucoside of young fustic, *Rhus cotinus*. The substance sometimes occurs as a chalky deposit in the cracks and shakes of the timber, and it may also be extracted from the wood shavings with boiling water. It melts at 218-219°, and is probably identical with the glucoside of *Rhodosphaera rhodanthema*, having the formula $C_{35}H_{30}O_{16}$. It forms a mono-potassium salt, and a corresponding ammonium salt. It is hydrolysed with extreme difficulty by boiling dilute acids.—A. R. **Penfold** and R. **Grant**: The economic utilisation of the residues from the steam rectification of the essential oil of *Eucalyptus cneorifolia* and the germicidal values of the crude oil and the pure active constituents. The dark-coloured waste product contains 6·5 per cent. australol (phenol) and 25 per cent. aromatic aldehydes, principally cryptal, the remainder being sesquiterpenes, etc. The active constituents when tested by the Rideal-Walker method have high germicidal values. The crude oil when emulsified with rosin soap has a coefficient of 6·5, and forms a cheap and powerful disinfectant.—A. R. **Penfold** and F. R. **Morrison**: The essential oil of *Eriostemon Crowei* (*Crowea saligna*). This tall shrub, found on the rocky sloping banks of creeks and rivers in the Sydney district, yielded 0·4 of an oil heavier than water; the principal constituent (90 per cent.) was a new phenol ether, for which the name "croweacin" is proposed. Its molecular formula is $C_{11}H_{12}O_3$, and it contains one methoxy group. On oxidation with potassium permanganate it yields a neutral body, $C_{11}H_{14}O_5$, of M.P. 93° C., and an acid, $C_9H_8O_5$, of M.P. 153° C.—M. B. **Welch**: A method of identification of some hardwoods. In search of an accurate method of identifying certain hardwood timbers, particularly the Eucalypts, extracts obtained by boiling a definite weight of shavings in a known volume of water were examined. Various reagents, such as ferric chloride, lime-water, etc., were added to the extract, and a comparison made between similar timbers. The method does not give results with certainty.—M. B. **Welch**: The resinous exudation of rosewood. The resinous exudation or "sweating" which destroys the polish of rosewood is due to numerous minute drops of oil in certain parts of the wood. A steam distillation of shavings gave a yield of more than 3 per cent. of a bluish-coloured oil. Sweating is apparently due to lack of seasoning, or to polishing a freshly prepared surface.—W. S. **Dun** and Sir Edgeworth **David**: Notes on the occurrence of Gastrioceras, at the Irwin River Coalfield, W.A., and a comparison with the so-called Paralegoceras from Letti, Dutch East Indies. *Gastrioceras Jacksoni* occur in the Gascoyne River district, W.A., in a very well-marked horizon in the Lower Marine Permian beds, which has been traced for more than 20 miles. A new form is identical with Haniel's *Paralegoceras sundaicum* from the Permian of the Island of Letti. This is associated with a brachiopod fauna of a definite Asiatic Permian facies, and it will thus be possible to attempt a more definite correlation of the Western Australian beds with the Permian of Asia and Eastern Europe.—W. R. **Browne** and W. A. **Greig**: On an olivine-bearing quartz-monzonite from Kiandra, N.S.W. An explanation of the very rare association of the two minerals olivine and quartz in the same igneous rock. The chemical composition of the rock is given.—W. R. **Browne**: Note on the occurrence of calcite in a basalt from the Maitland district, N.S.W. An account of a basalt containing about 15 per cent. of interstitial calcite, which is believed to be the result, not of surface alteration, but of deposition from magmatic waters during the crystallisation of the rock.—J. K. **Murray**: Notes on the bacteriological aspect of pasteurisation of milk for cheddar cheese-making. Pasteurisation, coupled with the use of a good starter, greatly favours those bacteria which produce a cheese of good flavour and aroma. The "pasteurised" cheese was better in flavour and aroma than the "raw" check cheese and did not markedly lose in texture or body. Its vitamin content is not considered to be in any marked degree different from that of the ordinary "raw" cheese.

MELBOURNE.

Royal Society of Victoria, December 14.—Mr. F. Wisewould, president, in the chair.—F. **Chapman** and I. **Crespin**: The Austral Rhynchonellacea of the "nigricans series" with a description of the new genus Tegulorhynchia. The forms of the "nigricans series," fossil and recent, in the southern hemisphere, which have been referred to the boreal genus Hemithyris, constitute a distinct zoological group Tegulorhynchia. The Cainozoic species of Tegulorhynchia have probably evolved from a Jurassic form like that of Burmirhynchia, without the intervention of the Cyclothyris type, which was so predominant in the Cretaceous of Europe. The direct line of descent is probably from the European type *Burmirhynchia variabilis*. The bathymetrical distribution of the forms living in southern waters has been found to be of value in comparing the stratigraphical characters of the fossil series.—J. R. **Tovey** and P. F. **Morris**: Contributions from the national Herbarium of Victoria, No. 3. The paper contains a description of a new species, *Kunyea sulphurea* Tovey and Morris, from West Australia, and records of new regional distribution of native and introduced plants. A new introduction, *Tradescantia fluminensis* Vell. (Water Spiderwort), is recorded and also some additions to the introduced flora of Coode Island.—H. S. **Baird**: The occipital bones of the Dipnoi. Sections of the exoccipital bone of Ceratodus, and comparison with a developmental series of Lepidosiren, show no evidence of endochondral ossification. It appears probable that the endochondral method of ossification—a phylogenetically more highly developed mode of bone formation—does not exist in the Dipnoi.—G. **Horne**: Aboriginal cylindro-conical stones. Cylindro-conical stones are found in the Darling district and West to L. Eyre. They are unknown by the Darling blacks; also by all except a few old men of L. Eyre tribes. These call them uncanny, being the petrified penis of one circumcised with a firestick before the moora introduced the knife. Afterwards the stones must be lost. Circumcision was unknown where the stones most abound.

Official Publications Received.

Académie des Sciences (Česká Akademie Věd a Umění). Bulletin International. Résumés des travaux présentés. Classe des Sciences mathématiques, naturelles et de la Médecine. 18e année (1913). Pp. iii + 397. 19e année (1914). Pp. iv + 415. 20e année (1916). Pp. iii + 408. 21e année (1917). Pp. iv + 408. 22e année (1920). Pp. iv + 225. (Prague.

Diary of Societies.

SATURDAY, MARCH 3.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual General Meeting) (at Carpenters' Hall), at 11 and 2.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (3).
GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Dame Helen Gwynne-Vaughan: The Mechanism of Inheritance.

MONDAY, MARCH 5.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—The Absolute Measurement of Magnetic Force. Chairman, Dr. C. Chree. Speakers: F. E. Smith, Sir Arthur Schuster, H. Spencer Jones (and possibly Dr. A. Crichton Mitchell).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Man's Posture: its Evolution and Disorders (1) (Hunterian Lectures).
SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—A. S. E. Ackermann: The Physical Properties of Clay (fifth paper) and the Dynamics of Pile-driving.
INSTITUTION OF RUBBER INDUSTRY (at Engineers' Club, 39 Coventry Street), at 6.30.—H. Savage: Telegraph Cable Manufacture, Rubber and Gutta-percha.
INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—J. H. Parker and others: Discussion on Control in Industry.
ARISTOTELIAN SOCIETY (at University of London Club), at 8.—E. S. Russell: Psycho-biology.
ROYAL SOCIETY OF ARTS, at 8.—J. E. Sears: Length Measurement (1) (Cantor Lectures).
SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Engineers' Club, 39 Coventry Street), at 8.—Dr. T. M. Legge: Industrial Poisoning and the Works Chemist.

TUESDAY, MARCH 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur E. Shipley: Life and its Rhythms (2). Rhythm in Living Organism.
ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Major E. A. Belcher: The Dominion and Colonial Sections of the British Empire Exhibition.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. G. Evans: The Nature of Arterio-sclerosis (1) (Goulstonian Lectures).
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—H. G. Cannon: A Note on the Zoea of the Land-Crab, *Cardisoma armatum*.—Miss L. E. Cheesman: Notes on the Pairing of the Land-Crab, *Cardisoma armatum*.—Dr. C. F. Sonntag: The Comparative Anatomy of Tongues of the Mammalia. VIII. Carnivora.—R. Kirkpatrick: A New Species of the Tunicate *Rhizomolgula* with remarkable Sensory Organs. No. 24. Results of the Oxford University Expedition to Spitsbergen, 1921.—T. H. Ring: The Elephant-Seals of Kerguelen Island.
INSTITUTION OF CIVIL ENGINEERS, at 6.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—K. C. D. Hickman: An Electric Indicator for Washing-troughs.—A. C. Banfield: The "Perfect" Camera.
RONTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.

WEDNESDAY, MARCH 7.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 10.—Dr. Aitchison: The Mechanical Properties of the Magnesium Alloys.—Prof. H. C. H. Carpenter and C. C. Smith: Tests on Work-hardened Aluminium Sheet.—Kathleen E. Bingham and Dr. J. L. Haughton: The Constitution of some Alloys of Aluminium with Copper and Nickel.—M. Cook: The Recrystallisation of Cold Worked Cadmium.—Dr. A. W. Gray: Volume Changes accompanying Solution, Chemical Combination, and Crystallisation in Amalgams.—At 2.30.—Dr. W. Rosenhain, S. L. Archbutt, and S. A. E. Wells: The Production and Heat Treatment of Chill Castings in an Aluminium Alloy ("Y").—Prof. F. C. Lea, Dr. V. A. Collins, and Dr. E. A. F. Reeve: The Modulus of Direct Elasticity of Cold-drawn Metals as a Function of Annealing Temperature.—A. M. Portevin: The Structure of Eutectics.—R. Genders: The Extrusion Defect in Brass Rods extruded from a Multiple Die.—S. Beckinsale: Further Studies in Season-Cracking and its Prevention. The Removal of Internal Stress in 60:40 Brass.
ROYAL SOCIETY FOR THE PROTECTION OF BIRDS (at the Middlesex Guildhall, Westminster), at 3.—Annual Meeting.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Man's Posture: its Evolution and Disorders (2) (Hunterian Lectures).
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—H. Morris-Airey: Development of Naval High Power Valves.
SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—A. Lucas: The Examination of Firearms and Projectiles.—R. C. Frederick: The Interpretation of the Results obtained in the Analysis of Potable Waters.—S. B. Phillips: Determination of the Purity of Vanillin.
ROYAL SOCIETY OF ARTS, at 8.—Prof. E. P. Stebbing: The Forests of Russia.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, MARCH 8.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 10.—R. C. Reader: Some Properties of the Copper-Rich Copper-Aluminium Alloys.—C. R. Austin and A. J. Murphy: The Ternary System Copper-Aluminium-Nickel.—Col. N. T. Belaiew: The Inner Structure of the Crystal Grain as revealed by Meteorites and Widmanstätten Figures.—A. L. Norbury: The Hardness of Annealed Copper.—A. L. Norbury: The Hardness of certain Copper Alpha-Solid Solutions.—At 2.30.—H. Heape: The Density and the Hardness of the Cast Alloys of Copper with Tin.—Dr. D. Hanson and Marie L. V. Gayler: The Heat-Treatment and Mechanical Properties of Alloys of Aluminium with Small Percentages of Copper.—Marie L. V. Gayler: The Constitution and Age-Hardening of the Ternary Alloys of Aluminium with Magnesium and Copper.—R. Genders: The Scleroscope Hardness Test. A New Form of Magnifier Hammer.—N. B. Pilling and R. E. Bedworth: The Oxidation of Metals at High Temperatures.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—T. Stevens: Water Power of the Empire (2).
ROYAL SOCIETY, at 4.30.—A. B. Wood, H. E. Browne, and C. Cochrane: Determination of Velocity of Explosion Waves in Sea Water. Variation of Velocity with Temperature.—P. M. S. Blackett: The Study of Forked Alpha Ray Tracks.—E. Hatschek and P. C. L. Thorne: Metal Sols in Non-dissociating Liquids. I. Nickel in Toluene and Benzene.—H. Hirata: Constitution of the X-Ray Spectra belonging to the L Series of the Elements.—A. Egerton: The Vapour Pressure of Lead. I.—A. C. Egerton and W. B. Lee: Some Density Determinations.—A. C. Egerton and W. B. Lee: Separation of Isotopes of Zinc.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. A. E. H. Love: Some Electrostatic Distributions in Two Dimensions.—J. P. Gabbatt: A Hyperspatial Analogue of Feuerbach's Theorem.—Prof. G. H. Hardy and E. C. Titchmarsh: Solutions of some Integral Equations considered by Bateman, Kapteyn, Milne, and Littlewood.—S. C. Dhar: Some Integral Equations connected with the Elliptic Cylinder Functions.—J. Vinogradow: Lattice Points in Regions of two or three Dimensions.—M. Merker: Génération et étude d'une surface du 3e ordre particulière.—H. W. Turnbull: The General Symbolic Notation for the Principle of Duality and its Application to Determinants.—E. W. Hobson: On Generalised Fourier Series.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. G. Evans: The Nature of Arterio-sclerosis (2) (Goulstonian Lectures).
ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. Sonntag and others: Discussion on The Vagus and Sympathetic Nerves and their Relation to Hydrology and Climate.
SOCIETY OF DYERS AND COLOURISTS (London Section) (at Dyers' Hall, Dowgate Hill), at 7.—B. Brown and H. Jordan: The Valuation of Dyestuffs by Titration Methods. (Rapid Commercial Estimation of Value.)
OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—H. Dennis Taylor: Optical Designing as an Art.—T. Smith: The Distribution of Correction Duties in Optical Instruments.
INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 8.—Open Discussion.
CAMERA CLUB, at 8.15.—H. Main: A Pilgrimage to Provence.

FRIDAY, MARCH 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Sir William Bragg: The Crystalline Structure of Anthracene.—Dr. A. B. Wood and Capt. H. E. Browne: A Radio-acoustic Method of locating Positions at Sea.—J. H. Powell and Dr. J. H. T. Roberts: The Frequency of Vibration of Circular Diaphragms.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Man's Posture: its Condition and Disorders (3) (Hunterian Lectures).
MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society of London), at 6.
INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Engineers' Club), at 7.—J. G. Clark: Gas as a Fuel.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—R. C. D. Fell: Rolling Mill Machinery.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—W. Sanderson: Over the Gemmi to the Valley of the Rhone.
INSTITUTE OF CHEMISTRY at 8.—E. J. MacGillivray: Some Aspects of the Law of England affecting Chemists.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. C. W. Saleeby: Sunlight and Disease.

SATURDAY, MARCH 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (4).
GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3—Conversazione.

PUBLIC LECTURES.

SATURDAY, MARCH 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Legends of the Gods of Ancient Egypt.

MONDAY, MARCH 5.

VICTORIA LEAGUE HOUSE (22 Eccleston Square, S.W.1), at 5.—P. D. Warren: Peeps at Ceylon Life, Industries, and Vegetation.
OVERSEAS CLUB AND LEAGUE (at Vernon House, Park Place, S.W.1), at 8.—W. R. Dunlop: The Work and Aims of the West Indian Agricultural College, Trinidad.

TUESDAY, MARCH 6.

LONDON SCHOOL OF ECONOMICS, at 5.—A. W. Flux: Statistics, before, during, and after the War: Prices.
SCHOOL OF ORIENTAL STUDIES, at 5.—Sir E. Denison Ross: Early European Intercourse with the East.

WEDNESDAY, MARCH 7.

UNIVERSITY COLLEGE, at 5.—Dr. A. H. Drew: The Cultivation of Tissues in Vitro (2). (Succeeding Lecture on March 14.)
KING'S COLLEGE, at 5.—Sir Herbert Jackson: Some Thoughts on the Relations of Science and Industry.

THURSDAY, MARCH 8.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 5.—W. Bayes: Painting and Architecture.

SATURDAY, MARCH 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Great Sea-serpent.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" *To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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NATURE

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CONTENTS.

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Preservation and Restoration.

ONE of the most important services which science can render to mankind is in the discovery of the precise origin of corrosion and decay brought about by natural causes and of methods of counteracting the destructive agencies. It becomes increasingly important to man to preserve, during such times as he may desire, the material fruits of his labour in their original form. Foodstuffs must be preserved during periods of plenty and during transportation to lands where they are scarce ; structures of wood, metal and stone must be safeguarded from the destruction caused by living organisms, water, frost, and the atmosphere ; fabrics must be protected from the deterioration brought about by light and bacteria. The annual monetary loss due to our lack of knowledge of the mechanism and counteraction of the phenomena involved is enormous and, in fact, incalculable.

For evidence of our ignorance in such matters it is only necessary to look at the stonework of almost any ancient building ; a cursory examination of some of our modern buildings will indeed suffice. Is it impossible completely to protect and preserve stone from decay and destruction ? Is the vast annual sum spent in protective paints for iron and steel structures really essential expenditure ? Such questions as these are at present unanswerable, but they are unlikely to remain so if adequate scientific research be directed to the problems so obvious to every one. Brearley's discovery of stainless steel, important as it is, is but a minor success in such a wide field, for the use of this material is greatly restricted by its price. Nevertheless, the discovery encourages the belief that, so far as metals are concerned, the broader problems are not insoluble.

Individually, the problems of corrosion and decay are not very attractive to the independent research worker of the present day ; the lure of more recondite fields of research is generally too powerful. But viewed collectively these problems are so important economically, and so far-reaching, as to call for co-ordinated investigation on a wide scale. In such investigations Government can and should play a valuable part as an organising and directing agency, and it is satisfactory to note the steps already taken in this country to initiate and to subsidise the necessary research. Perusal of the last Report of the Advisory Council for Scientific and Industrial Research (see NATURE, February 3, p. 165) shows that in addition to the assistance given to two professional bodies in aid of researches on special types of corrosion, the Department is carrying out several kindred inquiries under its own direction. Grants have been made to the Institute of Metals for the investigation of the corrosion of condenser tubes and of aluminium, and to the Institution of Civil Engineers for a research upon the deterioration of structures in sea-water. In direct association with the Department is the Food Investigation Board, which is dealing with the fundamental problems of food preservation. The Fabrics Research Committee and the Forest Products Research Board are interested in the protection of fabrics and woods respectively from decay, and we understand that a committee has recently been formed to inquire into methods of preserving stonework. Finally, by means of the laboratory which has been set up at the British Museum, the Department has provided for research into the causes and prevention of corrosion and decay occurring in museum specimens. Though each of these organisations has its own specific ends in view, judicious co-ordination of their efforts and intercommunication of the results they obtain will doubtless be of great assistance to the general progress.

A second report [1] on the investigations in progress at the British Museum has recently been published, and its appearance could scarcely be more opportune. The information it gives will be of great value to the curators of museums of antiquities and, we imagine, will be specially welcome to those who are engaged in the responsible and delicate task of recovering the archæological treasures of King Tutankhamen's tomb.

Little scientific research directly bearing upon the preservation and restoration of museum specimens has been undertaken in the past. Too often have the attempts at restoration been left in the hands of museum workmen whose empirical efforts have in some cases ended admirably, in others disastrously. Successful methods so devised have sometimes jealously been guarded as "trade secrets" guaranteeing continuity of employment. Such an unsatisfactory state of affairs cannot continue; if it is our duty—and indubitably it is—to preserve for future generations the evidences of past phases in the life of mankind, then it is essential that knowledge of trustworthy preservative processes should be communicated freely to all concerned. It is gratifying that Great Britain should take the lead in instituting scientific research of a very high order in this direction, and in publishing the results for the general benefit of all who are possessors or curators of valuable antiquities.

The Department has admittedly been very fortunate in enlisting Dr. Alexander Scott as director of the investigations which are being conducted at the British Museum laboratory. His second report, like its predecessor, shows abundant evidence of the high degree of experimental resource required in work of this kind, and of the very fragile character of many of the objects which he has successfully restored and protected from further deterioration. But in Dr. Scott the fears and caution of the antiquary are tempered by the confidence born of scientific knowledge; as a result of this happy combination we have on record the solutions to a number of problems which have long been a source of anxiety to museum curators. Prints and pictures, and objects of stone, silver, iron, lead, copper, bronze, and wood have all been brought to Dr. Scott for treatment, and subsequently have been returned to their places in the museum restored and insured against further attack.

The work at the British Museum laboratory has hitherto, naturally, been chiefly of a chemical character. But many museum problems have a microbiological aspect. The cellulose-destroying moulds and bacteria, for example, must play an important part in the decay of fabrics, paper, and other materials in museums; in time, doubtless, the laboratory will be able to turn its attention to these problems. Reference to such a development suggests the interesting possibilities which would be involved in a microbiological examination of the fabrics and cellulosic débris found in King Tutankhamen's tomb. Even though the examination proved negative so far as the discovery of spores of bacteria and moulds is concerned, valuable information would be yielded by the decayed material itself, for it is now known that cellulose fibres which have been attacked by such organisms show characteristic markings. We strongly hope that facilities will be given for such an examination to be made before the material has become infected with present-day organisms.

Attention should be directed to a feature of Dr. Scott's report unusual in Government publications, the excellent collotype illustrations; these supply striking visual confirmation of the successes he describes.

[1] "The Cleaning and Restoration of Museum Exhibits." Second Report upon investigations conducted at the British Museum. Published by H.M. Stationery Office, 1923. Price 2s. net.

Physiology in Medicine.

The Heart as a Power-Chamber: a Contribution to Cardio-Dynamics. By Dr. Harrington Sainsbury. (Oxford Medical Publications.) Pp. xii + 248. (London: Henry Frowde and Hodder and Stoughton, 1922.) 12*s.* 6*d.* net.

If we compare the text-books of physiology of to-day with those of twenty years ago, we cannot fail to be impressed, not only with the vast strides that have been made by the subject within this short time, but also with the fact that a large majority of the latest discoveries, which have an intimate bearing on the understanding and control of disease, could not figure at all in the physiological equipment of the men who studied medicine at that time and are now in the full tide of practice. Even the professional physiologist finds it difficult to keep himself abreast of the course of discovery in his own subject. It would seem, therefore, almost impossible to expect a man in a busy practice to appreciate what recent physiology has done and is doing for his science and for his craft. Many men, and those not the least successful, do not attempt the task, and trust to their craftsmanship and their powers of naming a diseased condition, that is, of placing it in a category familiar to them which they therefore believe they understand, and to their experience in treating such cases without, at any rate, harming the patient.

At the present time the condition is improved by the establishment of clinical units, of which the heads have time and opportunity, not only to advance their own subject, but also to keep abreast of the more important researches in the collateral sciences, so that they may serve to some extent as interpreters of the latter to their professional brethren. But even for the practitioner who is not so fortunately situated the task is not so impossible, if his training in physiology has been of the right character and has fallen on favourable soil. In the physiological training of the student it is not collections of facts or strings of arguments which are of supreme importance, but the method by which these facts are attained and the attitude of mind of the investigator. If he can carry this method and this attitude of mind into the wards, every case becomes for him a physiological experiment. Diagnosis is not the application of some appropriate label, but an understanding of what is happening in the body and how the disorder of any given function has come into existence. The whole of his practice becomes a research, and with one problem after another crying out for solution his attention and his curiosity are kept awake for any light which may be thrown by physiology or other science on the questions with which he has to deal. The true scientific physician must remain a physiologist during his whole life.

In the work under review Dr. Sainsbury shows that he has not forgotten the lessons in physiological method and thinking that he learned with Sidney Ringer. Taking as his text the action of the heart and the modifications that this may undergo in disease, he endeavours from his pathological and clinical experience to reconstruct the conditions in the living organism and, as he says, "to visualise the organs and tissues dynamically." He shows that in every case the test of structure must be the functional adequacy of the tissue. Given a case of heart disease the important thing is not an intimate analysis of the heart sounds and their modifications, but the knowledge of what the heart can do, and what are its powers as a pump, *i.e.* in maintaining the circulation of the blood.

In the first chapter, on the anatomical relations of the heart, the author gives an interesting series of measurements of the relative weights of the different parts of the heart, and shows that the muscular tissue surrounding each cavity is roughly proportional to the work that the cavity has to do in the maintenance of the circulation of the blood. Thus the muscular tissue of the auricles is roughly only one-tenth of that of the two ventricles, while the muscular tissue of the right ventricle as compared with that of the left ventricle is a little less than one-third of the latter ($1-2\cdot5$). In this case there would seem to be a discrepancy between the mass of the muscle and the actual work done by each cavity. It is probable that the work of the left heart is five or six times as great as that of the right ventricle. The smaller difference in the muscular tissue may be due to the greater mechanical disadvantage attendant on the arrangement of the muscular fibres of the right ventricle.

When we consider the enormous strain that may be thrown upon the walls of the left ventricle during exercise it is astonishing to find that one part of its wall, namely, that of the extreme apex, is only a few millimetres thick. Dr. Sainsbury points out that the heart would tend to rupture at this point if it had to sustain the full pressure of the blood during the ventricular systole. He suggests that at the very beginning of systole the blood is squeezed out from the apex by the preliminary contraction of the vortical fibres at this spot. As a matter of fact, Lewis has shown that the vortex of the left ventricle is one of the places where the wave of negativity preceding contraction appears earliest, though the time is short which elapses between the appearance of the wave at the apex of the ventricle and that at other parts of the two ventricles. It must be owned that electrical measurements give no support to the further hypothesis of the author, namely, that the circular band of fibres surrounding the left ventricle must contract later than the spiral fibres.

Attention is directed to a fact which often escapes notice, namely, the large size of the aorta and big veins as compared with the heart. Here we have a pump putting out about 4 oz. of blood at each stroke into a vessel 1¼ inches in diameter, and the big veins entering the heart have a total cross-section even larger. We should be almost justified in speaking, therefore, of an arterial sac and a venous sac, each serving as a reservoir of blood to supply the arterial system and the heart respectively.

It is always difficult to judge of the relative value of results obtained by different methods in a science with which one is not in daily contact. In Dr. Sainsbury's account of the venous pulse he raises difficulties which are really due to the attempt to make a minute comparison between the results of two methods, one of which is accurate to one-thousandth of a second, and the other only to one-twentieth of a second. By the optical method we can obtain very accurate records of the intra-auricular pressure. These show small elevations of pressure, one due to the contraction of the auricle, the second to the beginning of the ventricular systole and the sharp closure of the auriculo-ventricular valves, and the third to the accumulation of blood in the auricle during the continued contraction of the ventricle. A tracing of the venous pulse in the neck taken with a polygraph also shows three elevations which must have a similar causation. The middle one has been called the 'carotid pulse' by Mackenzie, and was ascribed by him to the pulse in the carotid transmitted to or through the jugular vein. This extraneous element in the venous pulse may possibly be often present in the tracings taken by this method, but it is really of not much importance whether it is external or whether it is due to the propagation of the wave of pressure which occurs in the auricle at the beginning of systole. Within the limits of error of the apparatus the 'c' wave may serve to mark the beginning of the ventricular systole, since it occurs either at the very beginning or within two-hundredths of a second afterwards.

In his description of 'tone' as applied to the heart, the author, in common with many clinicians and guided by the physiology of a few years ago, takes a view which I believe is erroneous. He describes tone as resistance to distension and therefore as a property which comes into play during diastole to prevent over-distension of the heart. Such a property would hinder rather than further the action of the heart pump. The filling of the heart is determined by the inflow. If the inflow increases, the rate of the heart (in the intact animal) increases *pari passu* so that this organ shall not be too distended. To prevent over-distension the strong fibrous sac of the pericardium is provided. It is important that the heart during diastole should present as little resistance as possible to distension, since any resistance would cause a rise of venous pressure and impede the circulation. If we examine the clinician's idea of a heart with good tone, we find he is really speaking of a heart with good contractile power, *i.e.* one which contracts strongly and empties itself, or nearly so, at each beat. The 'tone' would be measured rather by the systolic volume than by the diastolic volume of the heart. The term, however, is so ambiguous and has given rise to so much confusion that it would be better not to employ it at all in connexion with the heart.

There are certain other points which one might criticise, such as the part ascribed to the capillaries in the maintenance of the normal resistance of the circulation, as well as the mechanism of the absorption of drugs administered subcutaneously. But it is on account of its point of view that Dr. Sainsbury's book is useful and can be recommended to students. It might, indeed, be set to senior students as a subject of commentary and criticism from a physiological standpoint. If they could take the habit of mind of the author with them into the wards, their training in physiology would not have been in vain. E. H. STARLING.

Normal and Abnormal Psychology.

(1) *Beyond the Pleasure Principle.* By Dr. Sigm. Freud. Authorised translation from the Second German edition by C. J. M. Hubback. (The International Psycho-Analytical Library, No. 4.) Pp. v+90. (London: G. Allen and Unwin, Ltd., 1922.) 6*s.* net.

(2) *Fundamental Conceptions of Psychoanalysis.* By Dr. A. A. Brill. Pp. vii+344. (London: G. Allen and Unwin, Ltd., 1922.) 12*s.* 6*d.* net.

(3) *Studies in Psychoanalysis: An Account of Twenty-seven Concrete Cases preceded by a Theoretical Exposition.* By C. Baudouin. Translated from the French by Eden and Cedar Paul. Pp. 352. (London: G. Allen and Unwin, Ltd., 1922.) 12*s.* 6*d.* net.

(4) *Medical Psychology and Psychical Research.* By Dr. T. W. Mitchell. Pp. vii+244. (London: Methuen and Co., Ltd., 1922.) 7*s.* 6*d.* net.

(5) *The Measurement of Emotion.* By W. Whateley Smith. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. 184. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1922.) 10*s.* 6*d.* net.

(6) *Remembering and Forgetting.* By Prof. T. H. Pear. Pp. xii+242. (London: Methuen and Co., Ltd., 1922.) 7*s.* 6*d.* net.

(1) PROF. FREUD'S "Beyond the Pleasure Principle" is not a long essay; but it is exceedingly difficult to read, not only because of the style in which it is presented, but also on account of the philosophical ideas which the author attempts to express. It is packed full of observations, theories, and extensions of theories of great interest and originality.

The reader will not always, perhaps, be able to find himself in agreement with the argument; but he will certainly be stimulated to think. Originally, Freud's theory worked with fairly simple conceptions. The "pleasure-principle" emerged as a result of actual psychoanalytical practice. Any mental process originates in a state of tension, which is unpleasant; and, in virtue of this principle, moves towards relaxation. There is a tendency towards stability. But this tendency is met and checked by a "reality-principle" to which the sane psyche must adjust itself. Nevertheless, in the long run this too makes for pleasure. But phenomena are observed—certain forms of play in children, dreams in cases of war-neuroses, etc.—which seem to indicate a compulsion to repeat unpleasurable experiences. These show in a high degree an instinctive character. Considering this repetition of unpleasant activity, Freud accordingly puts forward the speculation that instinct might be "a tendency innate in living organic matter impelling it towards the reinstatement of an earlier condition."

Developing this speculation, Freud reaches the conclusion that the goal of instinct, as of life itself, is death. Originally, again, psychoanalysts had drawn a sharp distinction between the "ego-instincts" and the "sex-instincts." How, then, could an "ego-instinct" such as that of self-preservation have death as its goal? The answer is found to be given in Narcissism. Self-preservation is in reality libidinous. The libido is turned upon the ego and, *pro tanto*, away from the object. Accordingly, instead of the old distinction between the "ego-" and "sex-instincts," a distinction is now drawn between the "life-" and "death-instincts." These have striven together for mastery from the very beginning of the emergence of life from the inorganic. The "pleasure-principle" marks the "life-instincts" with the universal tendency of all living matter, namely, to return to the peace of the inorganic world. The "reinstatement-compulsion" lies behind it as well as behind the "death-instincts" of the organism.

Freud advances other highly ingenious and interesting speculations in his essay, of which one is a theoretical account of the development of the nervous system, open to the assaults of the exterior world only through a limited number of special channels which protect it from the prodigious energy without. But this nervous system is unprotected from the instinctive forces which arise within the body. These are not "bound" but free-moving nerve processes striving for discharge; and they give rise to disturbances comparable to the traumatic neuroses.

(2) Brill's "Fundamental Conceptions of Psychoanalysis" consists of the lectures of a course given to students in pedagogics in the University of New York. It is an elementary presentation of the Freudian principles and doctrine, and deals with the familiar topics of psychoanalytic literature—forgetting, stammering, lapses, mistakes, dreams, etc. There is an interesting chapter on the only child, another on selections of vocations. The book is diffuse, of a free-and-easy style, and full of Americanisms. It is published in England, but the type and spelling suggest that the plates were cast in America.

(3) Most people come to an inductive science with metaphysical presuppositions of one kind or another. In "Studies in Psychoanalysis" Baudouin makes a protest against the spirit of the systematiser, which has "been the bane" of the subject. The first part of the work is taken up with theoretical exposition. The second consists of 207 pages of case histories given in detail. The beginner is well advised, in the translators' preface, to commence with the cases and read the theory afterwards. He will thus be in a better position to examine the inductions made by the author in the light of the facts.

Baudouin links up psychoanalytic theory with general psychology. He is an eclectic, accepting principles from authors of widely differing views, and adding to them views of his own. His most personal contribution to the practice of psychotherapeutics is his conjoint use of psychoanalysis and suggestion. He is averse to the practice of either alone. The employment of the two methods together has been much criticised, many analysts condemning it outright; nevertheless it is difficult to see how suggestion can be kept out of an analysis. As the author remarks, "transference" is an effective relationship between the analyst and the patient, in which the ideoreflexes of suggestion occur naturally. This appears to be so; and therefore a controlled use of suggestion would seem to be reasonable. The present forms of suggestion and of analysis grew in two parallel lines of development from a common origin. Psychoanalysis was, in the first instance, practised on subjects in the hypnotic state.

The histories of the cases given are interesting, and range from those of quite young children to adults. The book is well translated. A good glossary of psychoanalytical terms is provided, as well as a bibliography and a very complete index.

(4) Dr. T. W. Mitchell is president of the Society for Psychical Research, and in his work on medical psychology he discusses a number of facts derived from abnormal and pathological psychology with the view of throwing light upon "psychic" problems. The main topic treated is multiple personality—for the account given of the appreciation of time by somnambules and the case of hysteria described in detail really relate to this. An account is given of an interesting series of experiments carried out by the author, which consisted in the performance of post-hypnotic suggestions involving the appreciation of lapse of time on the part of the subject. Mitchell considers that, whether

we treat the data as orthodox men of science or transcendentally, there is a large residuum of unexplained phenomena. In view of the controversy alluded to above, it is interesting to note that Mitchell's hysterical patient, in whom several "personalities" developed, was ultimately cured, partially by analysis carried out in the hypnotic state, and partially by word-association tests in the waking state. Besides the study of this case, the well-known classical cases are recounted and discussed.

The latter chapter deals with body and soul. The author examines the various psycho-physical theories in connexion with abnormal and pathological states; and the existence of a transcendental "soul," as the substrate of consciousness, is put forward as a legitimate hypothesis by which to account for some of the striking phenomena of multiple personality. Thus straying into the "vaguer regions of transcendental speculation," the author strangely makes no mention of hylomorphism, into which theory the facts would seem to fit as well as into those of Plato or Descartes.

(5) A great deal has been written on the emotions, both from the point of view of their expression and from that of introspective description. But it is only recently that much experimental investigation has been devoted to them. Mr. Whateley Smith attacks the problem in an experimental manner; and his "Measurement of Emotion" is one of the pioneer steps in that direction. The author, using the psycho-galvanic reflex, reaction times, and reproduction tests as indicative of emotional changes, carried out a series of experiments on fifty subjects in order to ascertain the effect of emotion upon memory. Measurements were taken for 100 reactions to stimulus words (modified Jung list), and a number of these words were later learned by heart and reproduced at intervals by the subjects. Thus a memory-value, to be correlated with the affective value of the words in question, was obtained.

It was found that affective tone is of two kinds, positive and negative, and that positively toned words tend to be remembered, while negatively toned ones tend to be forgotten. The galvanometer records both kinds of tone. Reaction times and failures in reproduction are, in general, signs of negatively-toned words. Reaction-word experiments were also carried out with subjects under the influence of alcohol. It was found in these cases that highly-toned reactions gained and moderately-toned ones lost; and that the reactions in general regressed towards an all-or-none, or protopathic, type. The research is a well-planned one, and some of the conclusions valuable not only in themselves, but also in their applications to other problems in psychology.

(6) Prof. Pear's work on memory is not an ordinary text-book on the subject. In the first place, it is a popular exposition, growing out of a nucleus of lectures originally delivered to officers of the R.A.M.C. on the normal functions of memory, intended to help them to estimate abnormalities in their patients. In the second place, its net is cast wide enough to include much that is usually not treated in formal discussions of the topic.

Pear deals with the nature of memory and the mechanism of remembering, as well as of the process of forgetting. There is an important chapter on the functions of the image, in which the question of "imageless thought" is treated, and much on dreams, their mechanism and analysis. This last has become very prominent of recent years in relation to memory in connexion with psychoanalysis. The book has appendices on synæsthesia, number-forms, muscular skill, and the significance for problems of memory of some recent experiments (Head's and Rivers's) on the nervous system. It is written in the characteristic breezy style of Prof. Pear, and should be of value as an easy introductory avenue to the subject of which it treats.

Carotin-like Colours in Plant and Animal Tissues.

Carotinoids and Related Pigments: the Chromolipoids. By Prof. Leroy S. Palmer. (American Chemical Society Monograph Series.) Pp. 316. (New York: The Chemical Catalog Co. Inc., 1922). 4.50 dollars.

TO all who are interested in the investigation of the colouring matters produced by Nature in the vegetable and animal kingdoms this work should be welcome. It forms one of a monograph series, being produced under the auspices of the American Chemical Society in accordance with an arrangement with the Inter-Allied Conference on Pure and Applied Chemistry which met in July 1919. The series will form a very valuable addition to chemical literature in the English language if all the volumes deal as thoroughly with their respective subjects as does this one.

The author restricts himself to red, orange, and yellow pigments which can be extracted from the tissues by fat solvents—the carotinoids and related colouring matters. The opening chapter contains a very necessary review of the nomenclature in use, in the course of which the various irregularities and overlappings that exist are clearly indicated and the methods of nomenclature used in the treatise itself is set out. This chapter is, of necessity, rather disjointed in character, and the section dealing with non-carotinoid plant pigments is poor. For the sake of convenience the author, when passing to the description of the carotinoids which occur in plant life, adapts the subdivision of his field into carotinoids in Phanerogams (ch. ii.) and carotinoids in Cryptogams (ch. iii.). Although, as admitted by the writer, there is no logical reason for so doing, as the various pigments are widely distributed through Nature, this method of treatment has been worked up in an interesting manner and the interest deepens as each group is dealt with.

Passing from plant to animal life, the literature concerning the occurrence of carotinoid pigment in Vertebrates (ch. iv.) and Invertebrates (ch. v.) is surveyed. Later chapters deal with the very highly interesting problems concerning the chemical and biological relationships which may exist between plant and animal carotinoids; also with the ideas that have been put forward concerning the functions which carotinoids perform in plant and animal life.

Three chapters are devoted to the description respectively of the methods of isolation, the properties and methods of identification, and the quantitative estimation of carotinoids. Interesting plates show the crystal forms of several pigments of this group, also spectrophotographic records of their absorption bands. A summary follows each chapter.

A comprehensive bibliography is included, and followed by author and subject indexes—which, however, cannot be described as complete. It is unfortunate that in places careless phraseology is used, which considerably detracts from the pleasure of the reader. The volume contains a very large mass of information that will be invaluable to all investigators working in this field.

Paradoxical Science.

The Constitution of the Universe. (The Theory of Intersistence), dedicated to my Subscribers. By Louis Stromeyer. Pp. xx + 255 + xv. (Bangalore: Higginbothams, Ltd., 1922.) n.p.

MOST secretaries of local scientific societies (as well as many other people) have experience of the man who possesses the type of mind exemplified in this book: a mind as attracted by scientific hypothesis as a moth to a flame, and as wanting in discretion as the moth. The author is a mining engineer in India, and in his preface writes not without some modest sense of his temerity in composing this book and inducing a number of friends to finance its publication. A few words of apology, however, and particularly the confession that it has been written hastily and without opportunity to consult proper scientific literature, will scarcely excuse so hardy a piece of presumption. No man occupied with practical affairs, especially if his work is based on the application of physical science, like mining, would fail to adopt an attitude of severe disapproval towards an amateur who, while confessedly ignorant, proposed to reverse all the conclusions arrived at by men experienced in these affairs, and to substitute wholly new theories and methods; yet most practical arts are relatively simple, compared with the vast and complex structure of modern science, which these amateurs are eager to raze and rebuild. It is, indeed, remarkable that this obvious consideration should not prevent men, often capable and successful in their own work, from embarking on so foolish an enterprise, and imagining that they

> "Can tell us easy how the world was made,
> As if they had been brought up to the trade,
> And whether chance, necessity, or matter,
> Contrived the whole establishment of nature."

This book bears the typical marks of its class: a title of ample scope, chapter-headings of appropriate vagueness ("The Fundamentals," "Form and Posture," "Co-ordination," "Phases," etc.), arguments in an involved pseudo-philosophical style, and, as befits such a work at the present day, preoccupation with relativity and the magic name of Einstein. By request, the author has included a chapter specially devoted to the criticism of "modern theories"; it is surprising to find the bulk of this devoted to objections against a subject so relatively simple as the kinetic theory of gases and of matter generally.

The objections here raised (and they are typical of those brought forward elsewhere in the book) merely show, when examined, that the theories in question have proved difficult to the author's comprehension, and difficulties of this kind are probably the bond of union between the author and his supporters. There is nothing to be ashamed of in finding theories difficult to understand, especially if, as is often the case, they require an acquaintance with mathematics and a background of physical knowledge which are themselves only attainable by careful study. Such difficulties are by no means a mark of inferior ability: the late Lord Rayleigh, for example, mentioned at a British Association meeting some years ago that he had formed no opinion on a certain result in the theory of diffraction, obtained by Sommerfeld, because to appreciate the matter properly would require a fortnight's serious reading, which he did not feel ready to give to it. But in science, as in religion, there are some who by their own unaided powers

> "Will undertake the universe to fathom,
> From infinite down to a single atom.
> . . . . .
> And, where they've least capacity to doubt,
> Are wont t' appear most perempt'ry and stout."

One is tempted, indeed, to go on quoting Samuel Butler, who, whatever the quality of his rhymes, summed up the truth of this matter in a few caustic passages. For language adequate to describe the obscurity and tedium of such books one would need the powers of a Swift or a Pope.

Our Bookshelf.

(1) *A New Manual of Logarithms to Seven Places of Decimals.* Edited by Dr. Bruhns. Thirteenth Stereotype edition. Pp. xxiv+610. (London: Chapman and Hall, Ltd., 1922.) 12*s.* 6*d.* net.
(2) *Tables of* $\sqrt{1-r^2}$ *and* $1-r^2$ *for Use in Partial Correlation and in Trigonometry.* By Dr. J. R. Miner. Pp. 49. (Baltimore, Md.: The Johns Hopkins Press, 1922.) 1 dollar.
(3) *Two-figure Tables.* Compiled by C. R. G. Cosens. On Card, 10 in. × 4¾ in. (Cambridge: Bowes and Bowes; London: Macmillan and Co., Ltd., n.d.) 6*d.* Quantities of one or more dozens supplied at 4*s.* per dozen.

(1) THE first table in this edition of Dr. Bruhns' Manual is a reprint of Köhler's table of logarithms of integers from 10000 to 100000, covering 180 pages. Auxiliary tables of proportional parts at the side of each page give all necessary assistance to a computer in finding the logarithms of six- and seven-figure numbers. Eight-figure logarithms of integers between 100000 and 108000 are not given, as in the original Köhler and the modern Chambers, " since the addition of logarithms of numbers from 100000 to 108000 does not appear to offer a sufficient advantage." With this we do not agree. Eight places of decimals in logarithmic work in dealing with numbers that slightly exceed 1·0 are only equivalent to seven places for numbers in the neighbourhood of 9·0. Within recent years the present reviewer was engaged in computing work in which the eight-figure logarithm was essential for numbers just greater than 1·0. In fact it was only regretted that the eighth figure was not available from 100000 to 115000.

There follow tables of the logarithms of sin x, cos x, tan x, and cot x, the entries being given at intervals of one second from $x=0°$ to $x=6°$, and at ten-second intervals from 6° to 45°. In the latter range six pages are assigned to each degree of arc, whereas one page is given to each minute from 0′ to 10′. The tables of differences and proportional parts on each page give every help needed in interpolation.

A few minor tables are added to the above main ones. The tables on each page are set out in an attractive way, and the new edition will be found to be a very serviceable one.

(2) The tables in this pamphlet give the numerical values of $\sqrt{(1-r^2)}$ and $1-r^2$ to six decimal places for values of r between 0·0 and 1·0 at intervals of 0·0001. Differences and subsidiary tables for interpolation are not appended. Thus the table gives the consecutive entries

$$\sqrt{(1-r^2)}=0·567026 \text{ when } r=0·8237,$$
$$\sqrt{(1-r^2)}=0·566881 \text{ when } r=0·8238,$$

and a slide-rule calculation is necessary to evaluate the function when $r=0·8237463$.

The tables were calculated with a view to their bearing on partial correlation coefficients: they serve equally to determine cos θ and cos² θ from sin θ by a single reading.

(3) On the two sides of this card are printed the numerical values of sixteen functions, x^2, x^3, $\sqrt{x}$, $\sqrt[3]{x}$, $x^{\frac{3}{2}}$, $1/x$, $\log_{10} x$, $\log_e x$, e^x, e^{-x}, $\sin x$, $\cos x$, $\tan x$, $\sinh x$, $\cosh x$, and $\tanh x$, the intervals for x being 0·1 between 0·0 and 5·0, and 0·5 between 5·0 and 10·0. In tabulating the circular functions, x is measured in radians and not in degrees. Except in special cases two-figure accuracy is retained throughout. This amount of accuracy is sufficient for plotting many elementary graphs for the purpose of which the card is primarily intended.

W. E. H. B.

Essai d'optique sur la gradation de la lumière. Par Pierre Bouguer. (Collection "Les Maîtres de la Pensée scientifique.") Pp. xx+130. (Paris: Gauthier-Villars et Cie, 1921.) 3 francs.

PIERRE BOUGUER was born at Croisic in 1698. At an early age he was initiated in mathematics and problems of navigation by his father, who was one of the best hydrographers of his time. When only fifteen years of age he occupied the chair of his father, who had just died, and afterwards distinguished himself by his researches in physics, astronomy, and navigation. He is remembered to-day principally by his work on photometry, and by his expedition to Peru in 1735 to carry out a measurement of a degree of latitude, thus contributing to the solution of the important problem of the figure of the earth. It was during this expedition that he obtained an estimate of the mean density of the earth from pendulum observations in the neighbourhood of Chimborazo. The present essay, in which he laid down the fundamental bases of the science of photometry, is reproduced from the original text of 1729. The author discusses methods of measuring the intensity of light, the manner in which the intensity is changed by reflection or by absorption, and explains how to calculate the diminution in the intensity after the light has passed through various thicknesses of the absorbing medium. His work is distinguished by its clarity and the masterly realisation of the essential points in the problem to be solved.

The Internal Combustion Engine: a Text-book for the Use of Students and Engineers. By H. E. Wimperis. Fourth edition (revised and enlarged). Pp. xvi+320. (London, Bombay and Sydney: Constable and Co., Ltd., 1922.) 12*s.* 6*d.* net.

IT is not surprising that a fourth edition of this valuable work should have been called for within thirteen years after its first publication. As is well known, the progress of the internal combustion engine during the war was very rapid, due largely to aviation. By rearranging some of the older matter, the author has been able to give an account of these advances, including recent experimental work on explosions in closed vessels, and modern fuels and fuel mixtures suitable for use in petrol engines. The chapter on the efficiency of petrol engines has also been brought up-to-date and now includes some matter referring to the loss of power at altitudes in aero engines. Two methods have been proposed for getting rid of this difficulty, namely, the production of an artificial atmosphere by means of a blower in the carburettor intake, or using an oversize engine, which is kept throttled down at low altitude. In either case, the object is to design an engine which can develop constant power up to a certain height. For altitudes up to 20,000 feet, the over-dimensioned engine appears to be considered the simpler solution.

Mazes and Labyrinths: A General Account of Their History and Developments. By W. H. Matthews. Pp. xviii+254. (London: Longmans, Green and Co., 1922.) 18*s.* net.

MR. MATTHEWS, who does not pretend to be a trained archæologist, tells us that his book originated in a question addressed to him by his little son as he played on the seashore. "Father, who made mazes first of all?" As his bibliography shows, he has studied the literature of the subject, and he has collected much information summarised in a popular way. He begins with the two great labyrinths of antiquity, that at Knossos in Crete, and the second near Lake Moeris in Egypt. In describing these, he depends on the safe guidance of Sir A. Evans and Prof. Flinders Petrie. The former was based on a tradition of the complex of buildings forming the royal palace, the latter was possibly used for sepulchral purposes. Though, as Sir James Frazer suggests, the dancing-places associated with these ancient labyrinths may have been used in some magical way connected with sun worship, it is difficult to connect them with modern mazes, like those at Hampton Court or Hatfield, adjuncts to garden planning, and intended for the amusement of visitors. The best part of the book is the collection from various sources of illustrations of various types of mazes. Many of these have been destroyed in modern times, and this book may serve a useful purpose in directing attention to their interest, and may tend towards the preservation of those which survive to our day.

The Outdoor Boy. Edited by Eric Wood. (The Modern Boy's Library.) Pp. 280. (London: Cassell and Co., Ltd., n.d.) 5*s.* net.

PROBABLY no class of the community takes a greater interest in the education of their sons than the readers of NATURE. While the most suitable form of education will long remain the subject of debate, few will deny the importance of the out-of-doors side, both from the point of view of awakening a love for and an interest in Nature and preparing for the duties of citizenship.

The book before us, one of a series edited by Mr. Eric Wood, is divided between scout-craft and Nature-craft, the idea being to convey to the boy in a clear and simple manner many of those things which he most wishes to know. The scout-craft section appears to us most admirable and should be a mine of information to many a boy who is unable to join an actual scout troop. The Nature-craft section consists of an excellent chapter on bird study and similar chapters packed with information about the insect world. Boys upon whom we have tried the test find it altogether admirable.

A Text-book of Quantitative Chemical Analysis. By Dr. A. C. Cumming and Dr. S. A. Kay. Fourth edition. Pp. xv+432. (London: Gurney and Jackson; Edinburgh: Oliver and Boyd, 1922.) 15*s.* net.

THE first edition of this book was published in 1913, and the appearance of the fourth edition less than ten years later shows that it has been found in practice a most useful guide to students. The present volume should provide a sound course of quantitative analysis for students in universities and technical schools. It is very practical, and gives many hints to students which will save the time of teachers. The reduction method with Devarda's alloy might have been given for the estimation of nitrates, instead of the one with reduced iron, which is less satisfactory. In the description of the Lunge nitrometer no mention is made of the important correction for the solubility of nitric oxide in the acid. The directions for the preparation of cupferron reagent on p. 410 will be found useful, as the price charged for this substance is almost prohibitive.

Group Psychology and the Analysis of the Ego. By Dr. Sigm. Freud. Authorised translation by James Strachey. (The International Psycho-Analytical Library, No. 6.) Pp. v+134. (London: G. Allen and Unwin, Ltd., 1922.) 7*s.* 6*d.* net.

A GOOD and clear translation of Freud's short essay on group psychology is given by Mr. Strachey. The work begins by a brief examination of the views of earlier writers, particularly of Le Bon and M'Dougall. Freud's own method of approach to social psychology is naturally by way of an analysis of the motives of individual behaviour. He treats the group as a collection of persons bound together by some form of love relationship, and to the formation of the group ascribes what to many will appear to be an overweighted importance to the leader. His discussions of the phenomena of "identification," and of the relations of "being in love and hypnosis," are interesting in themselves; but his application of the results of his discussions to the explanation of social behaviour is not convincing.

Elementary Organic Chemistry. By W. H. Barrett. Pp. 256. (Oxford: Clarendon Press; London: Oxford University Press, 1922.) 4*s.* 6*d.* net.

DURING the last two or three years a number of elementary books on organic chemistry have appeared, and it may be doubted whether any purpose is served by further multiplication of the same material treated in the same way. The present volume has no very new features, but it gives a very clear and interesting account of the fundamental facts and theories of organic chemistry suitable for students preparing for scholarships at the universities. It also provides a course suitable for those beginning the subject in the universities, and for medical students. Experiments are included. The section on stereochemistry is particularly good, and a chapter is devoted to general methods of synthesis and analysis. The very moderate price of the book and its undoubted merit should make it popular.

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.*]

The Optical Spectrum of Hafnium.

During the progress of the work of Coster and Hevesy on the concentration and isolation of the new element hafnium (atomic number 72), the discovery of which was announced in Nature of January 20, p. 79, we have examined spectroscopically a large number of their preparations in order to establish the optical spectrum of hafnium, and at the same time to assist in the chemical work on its isolation. In all our exposures we have for the sake of comparison also photographed the spectrum of a specimen of very pure zirconium prepared by Coster and Hevesy from commercial zirconium by removing the hafnium content.

The spectra were photographed with a Hilger quartz spectrograph of largest size, and in our preliminary work we have confined ourselves to the spectral region between 2500-3500 Å.U., which could be exposed in a single setting of the spectrograph. The spectra were produced in an ordinary carbon arc, the salts being placed on the cathode. The lines which are given in the table below as the most prominent hafnium lines in the region mentioned, are all lines which were not visible in an intense spectrum of the purified zirconium, while their intensity increased gradually in the preparations which by X-ray analysis were found to contain hafnium in increasing amounts. In the last specimens prepared by Coster and Hevesy, and estimated to contain about 90 per cent. hafnium, the lines ascribed to hafnium were among the most intense lines in the spectrum. In the table is given the wave-length λ in international Å.U. in air, measured against iron normals, and an estimation of the relative intensity I in the usual scale (strongest lines denoted by 6).

λ.	I.	λ.	I.	λ.	I.	λ.	I.
2559·05	3	2845·75	5	2954·20	5	3181·00	3
2637·00	4	2851·00	4½	2964·85*	5	3189·65	2½
2638·70*	4	2866·35*	6	3016·65	5	3206·10	3
2668·25	3	2887·15	4	3018·25	4½	3249·70	3½
2705·60	5	2889·60	5	3050·75	4	3291·10	3
2713·80	4	2898·30*	6	3056·95	4½	3309·55	2½
2718·50	4	2904·40*	4	3072·90	5	3310·35	4
2761·65	6	2904·75*	4	3080·80	4	3312·82	5
2766·90	3½	2916·50*	6	3097·75	3	3332·70	5
2773·05	4	2918·50	4	3156·65	4	3358·90	3
2779·35	4	2924·55*	3	3159·80	4	3373·95	2
2817·70	3	2929·90	4	3162·60	1½	3472·45	4
2833·30	3	2940·80*	6	3172·95	5	3497·40	4½

We have examined the hafnium preparations for the presence of the lines belonging to the characteristic spectrum ascribed by Urbain (*Comptes rendus*, t. 152, 1911, p. 141) to an element celtium belonging to the family of rare earths, and the discovery of which was announced by him several years ago. By Dauvillier and Urbain (*Comptes rendus*, t. 174, 1922, pp. 1347 and 1349; Nature, February 17, p. 218) this element was assumed to possess the atomic number 72. Not the slightest trace, however, of any of Urbain's lines appeared on our plates. Although the minerals used as starting-point for the work of Coster and Hevesy contained rare earth elements in considerable amount, the only elements besides hafnium which could be detected spectroscopically in their preparations were zirconium and titanium. It is interesting to notice that some of the most prominent hafnium lines have been present as weak lines in zirconium spectra measured by earlier investigators. Thus Bachem (Diss., Bonn, 1910) states the presence in his zirconium spectrum of the lines marked in the above table with an asterisk, and in several places he states without giving any measurements the presence of weak lines, which probably are identical with other of our hafnium lines.

A fuller account of the hafnium spectrum, with measurements of the wave-lengths of the characteristic lines throughout the region which is obtainable photographically, will appear shortly.

H. M. Hansen.
S. Werner.
Universitetets Institut for teoretisk Fysik,
Copenhagen, February 23.

Echinoderm Larvæ and their Bearing on Classification.

The object of my reply to Prof. MacBride (Nature, December 16, 1922, p. 806) was not to discuss the classification of Asteroids, but to protest against the character of his unprovoked attack on me. An adequate discussion of the question which group of starfishes is the more primitive, the Phanerozonia or the Spinulosa, requires very much more space than that allotted to a correspondence in Nature. What I wanted to prove—and, I think, did prove—was the want of foundation in Prof. MacBride's sweeping statement that all admit the Spinulosa to be the more primitive group, tending to represent my view as to this point as perfectly absurd.

Prof. MacBride now states (Nature, January 13, p. 47) that in my original work I "forgot that the Brachiolaria larva was found in Spinulosa but referred it to Forcipulata only." It is difficult to understand how I could have forgotten this, seeing that I have myself reared the larva of *Asterina pectinifera* and found it to be a Brachiolaria; moreover, in the very place (p. 220) where I arrive at the objectionable conclusion that the Brachiolaria is a specialised, not a primitive larval form, I begin with this statement: "While it would thus appear to be a rule that the larvæ of the Phanerozonia have no Brachiolaria-stage, the facts known of the development of the Spinulosa and the Forcipulata (Cryptozonia) seem to indicate that their larvæ are characteristic through having a Brachiolaria-stage." Is it too much to ask that, before thus criticising my work and accusing me of omissions, of which I am not guilty, or of absurd opinions (*e.g.* of regarding the metamorphosis of Echinoderms as metagenesis), which I have never set forth, Prof. MacBride would, at least, read the questionable paragraphs in that work? I have never stated that the case of the regenerating larva, *Ophiopluteus opulentus*, even if it undergoes complete metamorphosis a second time, must alter our views as to the signification of Echinoderm larvæ in general, only that this would represent a quite exceptional and unique case of metagenesis among Echinoderms.

Regarding the classification of Asteroids I will say only that the physiological and anatomical reasons given by Prof. MacBride for regarding the Astropectinids "as Asteroids secondarily modified for a life on sand" would scarcely be accepted as a sound basis for classification by any modern specialist on Asteroids, those "students of the external features of preserved specimens only," as Prof. MacBride rather contemptuously characterises them. May I only direct Prof. MacBride's attention to the fact that numerous Astropectinids live exclusively on a muddy bottom, and also that numerous Spinulosa and Forcipulata live on a sandy or muddy bottom.

Prof. MacBride states that my appeal to Dr. Bather's reply is quite mistaken, because I forget that "what Dr. Bather objected to was my [Prof. MacBride's] fathering of Dr. Mortensen's views on him." May I only quote the following sentence from Dr. Bather's reply; "It is not for me to break any lances in defence of Dr. Mortensen, but if Prof. MacBride is acquainted with Dr. Mortensen's 'Studies in the Development of Crinoids' . . . I am rather astonished that he should so belittle our Danish colleague's work on those lines." If this sentence is meant by Dr. Bather to express his substantial agreement with Prof. MacBride in their views on Echinoderms or to repudiate Prof. MacBride's fathering of my views on him, I am very sorry that I shall have to moderate very considerably the admiration which I have always had for his lucid way of expressing his opinions.

To Prof. Gemmill's remarks (Nature, January 13, p. 47) I must reply very decidedly that I am not narrowing down the Phanerozonia to include only the family Astropectinidæ. The families Luidiidæ, Archasteridæ, and Goniasteridæ, at least, are likewise typical Phanerozonia. On the other hand, the position of the Asterinidæ and the Gymnasteridæ is just one of the weak points in the classification of Asteroids, and the latter can by no means be said to be "frankly Phanerozonate."

The conclusion that, since the larvæ of the two families, Astropectinidæ and Luidiidæ (not of the Astropectinidæ alone as Prof. Gemmill states, by inadvertence, of course), regarded (by most specialists on Asteroids) as the more primitive forms, have no sucking disc, the existence of such a disc in the larvæ of those groups regarded (by most specialists on Asteroids) as more specialised types, is a secondary adaption, may, possibly, not be "inevitable"; but, in any case, this conclusion is not illogical or absurd. I have no direct interest in maintaining the Brachiolaria to be a secondarily specialised larval type. If conclusive proof is given that the Brachiolaria is the primitive, the Astropectinid-larva the specialised form, I shall not hesitate to drop my present view. But I must maintain that this view is not unjustified by the facts so far known.

I am sure Prof. Gemmill will agree with me as to the desirability of researches on the development and metamorphosis (and, not least, the postembryonal development) of many more forms than those few, which have been studied up to now. Not even the development and metamorphosis of Asteropecten has been studied by means of modern methods, the researches of Joh. Müller and Metchnikoff still remaining the only base of our knowledge of this subject. I hope very sincerely that Prof. Gemmill will extend his admirable studies to this and many other Asteroids, as I also hope that both he and Prof. MacBride will agree that my efforts to widen our knowledge of the development of Echinoderms are not entirely without value, and that the views expressed in my work, however much they may disagree in them, are not entirely without reasonable foundation.

Th. Mortensen.

Zoological Museum, Copenhagen,
January 22.

I shall summarise the points at issue between Dr. Mortensen and myself as briefly as possible.

He complains that I made an "unprovoked personal attack" on him. Nothing was further from my intentions. The so-called attack was a criticism of certain views attributed to Dr. Mortensen by Dr. Bather in a review of one of Dr. Mortensen's recent works in Nature. Dr. Bather seemed to think that Dr. Mortensen believed that after all the development of Echinoderms might be an alternation of generations as Johannes Müller originally suggested. As Dr. Mortensen has unreservedly repudiated this view there is nothing more to be said on this point.

But Dr. Mortensen did say that the fixed stage in the development of Asteroids (discovered by me in 1893) was of secondary character, because it was absent in two families (Astropectinidæ and Luidiidæ) classed together as Paxillosa. I had a perfect right to comment severely on statements such as these, because (1) the fixed stage is found in the most widely diverse families belonging to two of the great primary divisions of Asteroidea. (2) The fixed stage regarded as an ancestral reminiscence, enables us to understand how and why the ancestors of Asteroidea passed from the stage of free-swimming bilaterally symmetrical animals to the stage of radially symmetrical forms creeping over the bottom. (3) If Dr. Mortensen had known what he as a specialist in Echinoderms might reasonably be expected to know, namely, what has been determined as to the physiology and habits of Luidia and Astropecten, he could never have regarded them as primitive, but would have recognised them as what they are, the most specialised of all Asteroidea.

It is not a question of the ground on which particular starfish can be dredged up. Every marine biologist knows that sporadic individuals of rock and gravel-inhabiting species can be dredged on sand or mud. The dredge, indeed, gives no precise information as to the habitat of a species, for the bottom is usually "patchy." But Luidia and Astropecten *when observed in life* are found to be *burrowing species*, which when at rest are almost completely buried in the sand or mud in which they live like many Ophiuroids, and the structure of the arms is modified in relation to such habits. A fixed stage in the ontogeny of such forms would be an impossibility, for in such an environment the larva would find nothing to which it could attach itself. By a happy coincidence I received a few days ago Part V. of W. K. Spencer's "Palæozoic Asterozoa." In this work I read "The existence of large marginals throws no light on the affinity of extinct species, but it does throw light on the shape of the arm" (*i.e.* it is adaptive). When the arm is flat and the dorsal skeleton reduced to a flexible membrane the borders of the arms must be strengthened.

Dr. Mortensen accused me of referring contemptuously to certain specialist students of external features only. I am afraid I must plead guilty on this count. I have spent weary time in going through the ponderous works of Sladen and Ludwig, and so far as any attempt to correlate structure with function is concerned, these authors might just as well have been describing postage stamps as Asteroidea. The distinction between Phanerozonia and Cryptozonia was made by Sladen. The Phanerozonia were stated by him to be the original and primitive group (*a*) because fossil starfish were all phanerozonate, (*b*) because cryptozonate forms when young are phanerozonate.

I have never been able to find the evidence on which (*b*) is based. I have often seen young imagines of Asterias and Asterina, but there is certainly nothing "phanerozonate" in their appearance. Statement (*a*) is absolutely inaccurate. If Dr. Mortensen is open to conviction on this point let him study W. K. Spencer's monograph, where he will find every fossil form from Palæozoic strata carefully described, and further, an attempt made to correlate its structure with its probable habits. He will learn that Cryptozonia are just as old as Phanerozonia, and that the oldest starfish of all are neither Cryptozonate nor Phanerozonate and have no plates corresponding to the marginals of Astropecten at all.

Lastly, as to the accusation that I belittled Dr. Mortensen's work. I have no wish to depreciate his work, but with the exception of the treatise on the Crinoids (Comatulidæ), which is irrelevant to the point at issue, it is not what I regard as embryology at all. By that term I understand the attempt to follow through the development of the organs of the adult from their beginnings in the embryo or larva with a view of obtaining light on the ancestry of species. Dr. Mortensen's researches on Echinoderm larvæ have been purely classificatory, and he has done valuable work in determining which larval forms belong to certain adults. His recent work on Comatulidæ, it is true, is embryological: he has confirmed the results of Bury and extended them to other species; but he dismisses the conclusions of other embryologists without sufficient consideration of facts.

E. W. MACBRIDE.

Imperial College of Science and Technology,
South Kensington, London, S.W.,
February 2.

Medical Education.

I AM sorry Prof. Dakin (NATURE, February 3, p. 151) should think my letter (NATURE, January 13, p. 50) merely an attempt to open another discussion on evolution. I do not know how I could have expressed myself more clearly. Manifestly, a knowledge of such things as the anatomy of frogs and dog-fish cannot persist in the minds of medical students or be useful to them intellectually or professionally unless linked with other studies. They can be so linked only through truths about development, variation, heredity, and evolution. But here the naturalist is in conflict with the physiologists, psychologists, pathologists, and medical men into whose hands the students pass and whose opinions, abundantly supported by evidence, they always adopt.

It is one thing to demonstrate that evolution has occurred, and for this none are better qualified than naturalists. But evolution is not disputed by medical men, though, owing to the biology they learn, few give it a thought. It is quite another thing to demonstrate the method of evolution. Here, to say the least, naturalists are not in a position to ignore evidence derived from other sciences. For example, they have very diverse opinions about fluctuations. But did ever a naturalist see a fluctuation in a living being existing under natural conditions, other than man (*e.g.* a sparrow or house-fly, the most familiar of all)? If he did, was he able to follow that being throughout its career and test the influence of that fluctuation on its life? If he did, was he able to note the effect on offspring and descendants?

Very obviously our whole *immediate* knowledge of fluctuations, natural selection, and the method of evolution is derived from human beings, among whom alone we are able to observe with that sufficiency and minuteness which extreme familiarity confers. Thus every man (not only Prof. Dakin's superman) knows that powers of resisting the carnivorous bacillus of tuberculosis occur in all shades between wide extremes (therefore they are fluctuations); that they tend to run in families (therefore they are inheritable); that the less resistant tend to perish and the more resistant to survive (therefore there is natural selection); that every race is resistant n proportion to the length and severity of its sufferings (therefore natural selection is the antecedent of evolution); and that what is true of tuberculosis is true also of every lethal and prevalent disease (therefore the instances are in thousands and include all the world and all humanity—indeed every case in which we are able to observe closely).

Naturalists, unable to observe either fluctuations or natural selection among plants and lower animals, must get their ideas about the method of evolution either from observations on man or else through mere guessing. Apparently they prefer not only to guess but to claim scientific status for their guesses. After all, man is an animal. I do not know why he should be thought unworthy of study.

What does Prof. Dakin mean by "it is highly desirable that first-year medicals, raw youths from school, should make their first acquaintance with the animal world through less expensive material than human bodies"? Expensive in what—money or time? Does Prof. Dakin suppose that raw youths dissect fewer humans because they dissect more frogs?

I gather that he disapproves of attempts by me to discuss evolution, "for his letter indicates a very imperfect acquaintance with biologists and their work." I think by biologists he means zoologists and botanists. But, if I be incapable, why not end the nuisance by indicating my errors. A jury always grows suspicious when not the evidence, but only the opposing attorney is attacked. There has been much of this hinting at my ignorance—doubtless with reason, if not with proof. Nevertheless, I know some elementary facts which, it seems, are outside the range of the average naturalist, *e.g.*, that events do not happen (characters do not develop) without antecedents (nature) and exciting causes (nurture); that living beings are bundles of adaptations; that the multicellular organism springs from a germ in which are none of the characters it afterwards develops, and therefore, inherits nothing but its nature (the sum of its potentialities for development), and develops nothing except in response to nurture; that our powers of observation are proportionate to our familiarity with the objects of study; that whenever we are able to observe sufficiently closely we always find natural selection in full swing; that the variations selected by Nature are always fluctuations; that the result is always adaptive evolution; that man, unlike Nature, frequently selects mutations; that therein lies the difference between natural and artificial selection; and so on.

On these elementary facts I have founded some equally elementary questions. Why are some characters supposed to be more innate, or acquired, or inheritable than others? What precisely was the great Lamarckian controversy about? Was it founded on anything but a play on words? Why is the word inherit used with two directly contrary meanings? What is meant by the statement that "Nature is five perhaps ten times stronger than nurture," and what by the statement that "mutations, but not fluctuations, have their representatives in the germplasm"? Why, in the face of enormously massive evidence, is it supposed that there is no natural selection, or that natural selection is merely a preserver, not a creator, of adaptations? Why in the face of equally massive evidence is it maintained that the inheritance, not merely the reproduction, of mutations is independent? And so on. I notice that the erudite people who are so ready to proclaim my ignorance are not equally ready to face these facts and answer these questions. Nevertheless, both facts and questions, however elementary, are fundamental. Unless they be met, posterity will regard a page of Darwin, who always met his difficulties with candour and without arrogance, of more value than all the thousand publications of those who bark at the dead lion.

As Prof. Dakin has been good enough to suggest that I am ignorant, may I supply him with proof and the readers of NATURE with a test? I do not know what naturalists (the biologists of Prof. Dakin) mean by their key-words "innate," "acquired," and "inherited" when applied to characters. Does Prof. Dakin know? Will he tell us?

G. ARCHDALL REID.

Southsea, February 19.

A Relativity-predicted Mechanical Effect in the Electromagnetic Field.

THE present writer would certainly starve if his bread depended on supplying a certain experimental verification here asked for. It should, however, be mere Boys' play to those who measure the gravitational constant with a little pile of sovereigns and a quartz fibre, or who photograph the wake of a flying bullet. The mathematical argument leading to the prediction indicated below is sent to England by the mail carrying this letter, for publication, but I cannot say where and when it will appear.

A body, say a crystal, at rest in an electromagnetic field should experience a force per unit volume, in Maxwell's notation and in E.M. units, equal in magnitude and direction to

$$\mathrm{VKB} - \mathrm{ES}\nabla\mathrm{D} + \frac{d}{dt}\mathrm{V}(\mathrm{DB} - \mathrm{EH}/4\pi c^2),$$

where K is conduction current and c the velocity of light *in vacuo*. It is possible that the third term has been given before, but I have not seen it anywhere. The verification here asked for is that of the existence of this term. VEH is in the direction of a light ray and VDB is normal to the corresponding front. In an isotropic transparent body, VDB $=k^2(\mathrm{VEH}/4\pi c^2)$, where k is the index of refraction.

Unfortunately, $4\pi c^2$ is about $10^{22} \times 1{\cdot}131$, but my son, Dr. A. L. M'Aulay, tells me that the magnitude of VEH may readily be made equal to 10^{16}, so that the effect may be detectable.

The term indicates that when a wave-train traverses a point the matter at the point is always urged along the ray *towards* the nearest wave-crest or wave-trough, and normal to the front *from* the nearest crest or trough. Can any reader suggest a plausible physical reason why this should occur?

I may remark that Maxwell's expression for the force per unit volume is

$$\mathrm{V}(\mathrm{K} + d\mathrm{D}/dt)\mathrm{B} - \mathrm{ES}\nabla\mathrm{D},$$

and that probably most relativists would drop the $d\mathrm{D}/dt$ from this expression. Let the physicist tell us which, if any, of the three expressions is verified experimentally.

ALEX. M'AULAY.

University of Tasmania, November 28, 1922.

The Measurement of the Rates of Oxidation and Reduction of Hæmoglobin.

WE have recently been engaged on the determination of the velocities of the chemical reactions of hæmoglobin. These are of interest both to the physiologist because of the important part played by this pigment in respiration, and also to the physical chemist because this pigment is an almost unique example of a large complex protein molecule which combines with gases in a simple chemical manner. Some of the results that we have obtained and the methods we have used may therefore be of interest to readers of NATURE.

In order to measure the rate of reduction two solutions were prepared: (*a*) a 1·5 per cent. solution of whole blood in tap water, (*b*) a solution of sodium hyposulphite ($Na_2S_2O_4$) in tap water which was rendered neutral to brom-thymol-blue by the addition of sodium carbonate solution. These two solutions were by suitable means forced under a pressure of, roughly, 500 mm. of mercury into the mixing chamber of the measuring apparatus through conical jets of small bore, so that the two solutions underwent vortex motion at a high rate of speed. Preliminary tests of the measuring apparatus, using as fluids a sodium hydroxide solution containing phenol phthalein and a rather stronger solution of acid, showed that mixing and chemical combination were complete with one measuring apparatus in less than 0·0055 sec., and with another apparatus in less than 0·0005 sec. The mixed blood solution and reducing agent passed from the mixing chamber of the apparatus in use down a glass tube with known velocity, being examined at different positions by means of the reversion spectroscope, by which we could ascertain the ratios of those amounts of hæmoglobin still combined with oxygen and those in the reduced state.

We thus obtained the concentration of oxyhæmoglobin (O_2Hb) at a series of instants, the intervals between which could be readily obtained from the rate of linear flow of the solution down the tube, and the positions of the points examined by the spectroscope.

Experiments on the rate of reduction of oxyhæmoglobin (O_2Hb) by the reducing agent ($Na_2S_2O_4$) have shown that with increase of concentration of the latter the rate of reduction increases to a maximum, beyond which it cannot be raised by a further increase. This we take to mean that the process consists of two stages:

(1) Reduction of oxyhæmoglobin, *i.e.*
$$O_2Hb \rightarrow O_2 + Hb.$$
(2) Removal of O_2 (liberated from O_2Hb) by combination with the reducing agent.

As the concentration of the reducing agent is increased, the free oxygen formed from O_2Hb by stage 1 is removed more quickly, until a concentration is reached at which the "free" oxygen is removed so quickly that the reaction $O_2Hb \rightarrow O_2 + Hb$ is not appreciably opposed by the reverse reaction $O_2 + Hb \rightarrow O_2Hb$. Further increase in concentration of the reducing agent cannot therefore further accelerate the velocity of the reduction of the O_2Hb, the latter being now solely determined by the velocity of the reaction $O_2Hb \rightarrow O_2 + Hb$. We have other evidence in support of this view, which we hope to present at length elsewhere. The time taken for complete reduction of O_2Hb when the concentration of $Na_2S_2O_4$ was sufficient to secure the "maximum" rate of reduction was about 0·5 sec. at 12° C. This rate of reduction is such as to be a factor of importance in considering the conditions which determine the rate of uptake of oxygen by organs within the body. We found further that the logarithm of the concentration of O_2Hb when plotted against time gave a straight line relationship, as should indeed be the case if the reduction of O_2Hb is a monomolecular process.

The measurements of the velocity of oxidation of hæmoglobin required the preparation of large quantities of reduced hæmoglobin solution. This was obtained by spraying a solution of blood in tap water heated to 50° C. into a large vacuous container, thus causing the gases combined with the hæmoglobin to be liberated. This reduced blood solution was mixed with water containing dissolved oxygen by forcing both fluids into the mixing chamber of one of the observing apparatus described above. It was found that the combination was a very rapid one, the reaction being complete in one hundredth part of a second at 10° C. At body temperature it is probable that the velocity would be even higher. This gives some idea of the intense rapidity with which oxygen entering the blood, as the latter passes through the lungs, becomes chemically combined with hæmoglobin. It seems to us possible that similar methods might be useful for determining the velocity of other rapid chemical reactions.

H. HARTRIDGE.
F. J. W. ROUGHTON.

Physiology Laboratory, Cambridge,
February 7.

Stages of Golgi Bodies in Protozoa.

IN the *Anatomischer Anzeiger* (47 Band, 1914) Jan Hirschler, in his paper "Ueber Plasmastrukturen in den Tunicaten-, Spongien-, und Protozoenzellen," gives a description of the trophozoite of *Monocystis ascidiæ*, in which he figures Golgi bodies. This has never hitherto been confirmed, nor are any other stages known.

For some time we have been carrying out work on an Adelea, and after considerable difficulty succeeded in getting excellent preparations of the Golgi apparatus in many stages of the life cycle. In the accompanying illustration (Fig. 1) is the young

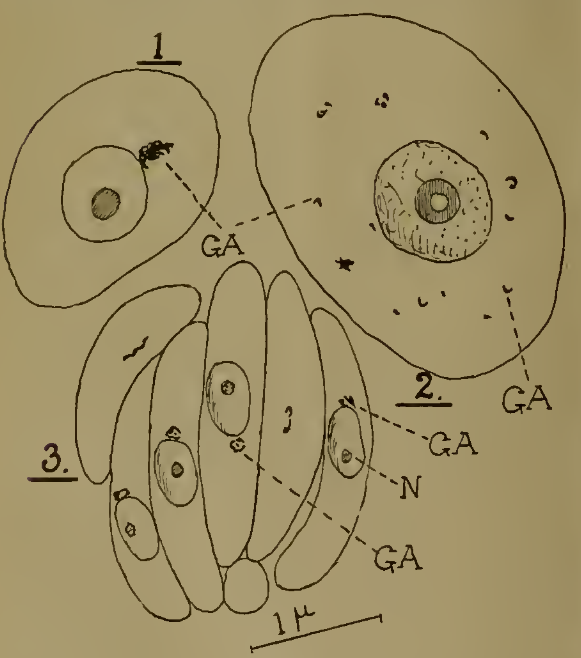

FIG. 1.

trophozoite showing an excentric and juxta-nuclear apparatus (GA); 2, the older trophozoite has a scattered apparatus, and in the "corps en barillet" stage in 3 the apparatus in each cell is again juxta-nuclear and excentric. The work is still proceeding in several species, and this is merely a preliminary announcement.

S. D. KING.
J. BRONTË GATENBY.

Zoological Department,
Trinity College, Dublin.

Selective Interruption of Molecular Oscillation.

MR. FAIRBOURNE (NATURE, February 3, p. 149) has reopened a subject which I believed was certainly closed; but since the fallacy is practically the same as before, though a little less easy to detect, I feel that I cannot then have been sufficiently clear for him.

None of Mr. Fairbourne's arguments has yet disposed of the validity of the ordinary treatment to be found in any text-book on the kinetic theory; for the elementary kinetic treatment of gaseous pressure is independent of the diameters of the gas-molecules, and would be perfectly valid if they were, as for the first approximation they are assumed to be, particles of a finite mass but zero radius; in this case, however, the mean free path would be infinite at every pressure, so that Mr. Fairbourne has introduced no new factor by confining himself to the case of long free paths.

This being so, it is not to be expected that space can be found in these columns for a disproof of whatever inadequate alternative to the accepted methods of analysis may be brought up; but I suggest that in this particular case he has not proved that he has satisfied a condition which he admits is vital, namely, that the numbers of molecules crossing XY and AD *in unit time* must be shown to be not proportional to their lengths. Many of the "superfluous" molecules which ultimately cross XY spend first a long time in the cone; there is nothing in his treatment which prevents such molecules being counted a very large number of times, since all points on their long paths may equally be taken as centres of small spheres O. Mr. Fairbourne's treatment is inconvenient; but it is obvious, since it does not discount the classical method, that, if carried out correctly, even it would have given the classical result.

I have always maintained that the length of the mean free path is irrelevant; I observe that he now admits this ("Subsequent intermolecular collision in the cone cannot destroy the excessive downward bias," etc.). The inevitable conclusion, as I pointed out last July, is that the pressure is without any influence except on the *magnitude* of the effect. It being granted that the molecules do not interfere with one another in any relevant way, the effect must be directly proportional to their number, *i.e.* to the total pressure. At atmospheric pressure, therefore, perpetual motion should be an accepted phenomenon even if the effect were measurable only with ambiguity at the pressures used by Mr. Fairbourne.

R. D'E. ATKINSON.

Hertford College, Oxford,
February 13.

A Biochemical Discovery of the Ancient Babylonians.

AT a lecture given recently in Cambridge by Prof. Okey my attention was directed to a passage written by Galileo in 1623 in which this pioneer of scientific method attacks the doctrines of the classical philosophers with his usual irony and vehemence. I refer to a section of his "Il Saggiatore," in which Galileo replies to his contemporary Sarsi, who had quoted Suida to the effect that the Babylonians used to cook eggs in an emergency and when no fire was available, by rapidly whirling them in slings. ("Babylonii iniecta in fundas ova in orbem circumagentes, rudis et venatorii victus non ignari, sed iis rationibus quas solitudo postulat exercitati 'etiam crudum ovum impetu illo coxerunt.' " Suida, Lessicografo. Bizant., x.)

Galileo makes the following caustic comments: " Se il Sarsi vuole che io creda a Suida, che i Babilonii cocesser l' uova col girarle velocemente nella fionda, io lo crederò; ma dirò bene, la cagione di tale effetto esser lontanissima da quella che gli viene attribuita, e per trovar la vera io discorrerò così: Se a noi non succede un effetto che ad altri altra volta a riuscito è necessario che noi nel nostro operare manchiamo di quello che fu causa della riuscita di esso effetto, e che, non mancando a noi altro che una cosa sola, questa sola causa sia la vera causa. Ora, a noi non mancano uova, nè fionde, nè uomini robusti che le girino; e pur non si cuocono; anzi, se fusser calde, si raffreddano più presto; e perchè non ci manca altro che l' esser di Babilonia, adunque l' esser Babiloni è causa dell' indurirsi l' uova e non l' attrizion dell' aria: che è quelo ch' io volevo provare." (If Sarsi *commands* me to believe on the authority of Suida that the Babylonians used to cook eggs by swiftly swinging them in slings—I will. But I will certainly say that the cause of such results is far from that which he attributes; and in order to discover the true cause I will reason in the following way: If we do not succeed in obtaining a result which was successfully obtained at another time, some one factor at least must be lacking which is necessary for the successful production of the result. Now, we have no lack of eggs, nor slings, nor strong men to swing them, *and yet they do not cook; on the contrary*, if already warmed the swinging would cool them more quickly. Since the only factor that is lacking is that we are not Babylonians, therefore the fact of being a Babylonian is the cause of the eggs solidifying, and not the friction of the air: and this is what I set out to prove.) (Galilei, Opere, vi. Also in " Frammenti e Lettere " (1917), p. 66).

If Galileo had actually put his experiment to the test he might have written otherwise. Within the last few years it has been " discovered " that egg white under mechanical strain such as *vigorous shaking* or very high hydrostatic pressure undergoes coagulation (*vide* Robertson, " Physical Chemistry of the Proteins," 1918). In a paper to be published shortly in the Proc. Roy. Soc. (read at the meeting of February 15), I show that chemical changes which occur on heat-coagulation also occur on coagulating an egg by mechanical means.

The myths and anecdotes of the ancients are almost invariably built on some foundation of fact; and it seems highly probable that the Babylonians were aware that eggs could be coagulated by vigorous movement (such as swinging in slings). If this be so, the phenomenon of mechanical coagulation proves to be another example of a former observation rediscovered—in this case after the lapse of thousands of years!

Leslie J. Harris.

Emmanuel College, Cambridge,
February 16.

Use of Yeast Extracts in Diabetes.

We have recently shown (*Journ. of Physiol.* 57, p. 100, 1922) that there is present in the blood of normal persons a sugar of a reactive nature, which gives the same osazone as glucose, but has a lower rotatory power. In the blood of persons suffering from severe diabetes mellitus, this sugar is not present in amounts capable of detection. In conjunction with Dr. Devereux-Forrest, we have found that, after administration of insulin to diabetic persons, whereas the quantity of sugar in the blood is decreased, the amount of normal blood sugar is increased.

We have also shown (Proc. Physiol. Soc., December 16, 1922) that extracts of pancreas and liver together alter the rotatory powers of glucose and fructose *in vitro*. It was suggested that the absence or inactivation of either the pancreatic or liver factor was the cause of diabetes. Since the pancreatic and liver factors were markedly accelerated by the addition of phosphates, it seemed possible that one constituent of the pancreatic factor might be a sugar-phosphoric acid complex. As an essential step in the metabolism of sugar by yeast is held to be the formation of hexose-phosphoric acids, it seemed possible that an extract of yeast might take the place of the pancreatic factor.

We have obtained a solid preparation from yeast which would appear to have similar properties and effects.

When a solution of this substance is injected into rabbits, a very definite lowering of the blood sugar occurs, in every way comparable to that which we have found after injections of insulin. Rats when injected die in convulsions similar to those caused by insulin.

Some properties of insulin and of this extract of yeast are very similar. Both contain organic phosphorus and carbohydrate. Seliwanoff's reaction is positive in each case after hydrolysis.

We are at present engaged in a further investigation of these extracts.

L. B. Winter.
W. Smith.

Biochemical Laboratory, Cambridge,
February 16.

Meteorological Nomenclature and Physical Measurements.

In reply to Sir Napier Shaw's kindly rejoinder in Nature of February 17, p. 218, to my meditations on the progress of meteorology, I prefer to his simile of a boat-race that of boats striving to tow the not yet quite ship-shape bulk of meteorological research forward on its destined course. Although Sir Napier Shaw's was the best equipped of the boats, in which he was able to experiment with new modes of propulsion, I am sure he recognises that I was pulling with all my strength, if independently, at least in the same direction as himself. That I pulled in grim earnest with the result of long disablement accounts for my present position (which strikes me as more desolate than dignified) on the shelf, from which I see the now graceful lines of the new meteorology moving ahead with Sir Napier's new engines installed, and though almost out of hearing I listen to their beat in order to form an opinion as to how they act. I should be sorry indeed if anything I said were to retard or discourage any one on board that craft or cast a shadow on the laurels with which Sir Napier Shaw has been crowned by the scientific world to the joy and pride of every British meteorologist.

Dropping metaphor, there is surely large room for helpful difference of opinion as to terminology and the relative value of facts and formulæ. I do not dislike the metric system in spite of its occasional awkwardnesses, nor would I hesitate to embrace the millibar if it seemed to me to be making for unity instead of adding a new ramification to diversity. In the works I was reviewing I failed to see the signs of the coming of the millenium of the millibar; but if it is on its way, " come it will for a' that."

Hugh Robert Mill.

February 19.

The Origin or Basis of Wireless Communication.[1]

By Sir Oliver Lodge, F.R.S.

Finsbury Technical College has done splendid work throughout its short history. It fills a distinct niche, it supplies a felt want in the education of the Central metropolis, and I hope that any idea of closing it has now subsided. It has had, moreover, a brilliant array of teachers, men who appeared specially adapted to serve the needs of its special kind of students. I will here only mention three contemporaries who worked together after 1885, when the initial start had been made, and the early traditions settled, by Ayrton and Perry. Silvanus Thompson became principal in 1885, and had as his colleagues John Perry and Raphael Meldola. John Perry was remarkable as a teacher, and did his best to cultivate a wider interest in the rather narrow technically trained students who came under his paternal supervision, encouraging them to read novels, to take an interest in literature, and—even in mathematics—to take a broader outlook than most teachers thought it worth while to cultivate. As for Silvanus Thompson, the breadth of his outlook and width of his interests are almost proverbial. He represented a rare combination of scientific aptitude and high artistic faculty, together with a fondness for literary study among archives, and he became in the eyes of all his contemporaries—including Lord Kelvin and Lord Rayleigh—a recognised historian of science. He had a keen love of the past and of discoveries in their nascent stages. Old documents and records were of real interest to him: and he used to do his best to dig out of obscurity some of the pioneers and early workers towards developments which afterwards became famous.

Early pioneering work is too often overlooked and forgotten in the rush of a brilliant new generation, and amid the interest of fresh and surprising developments. The early stages of any discovery have, however, an interest and fascination of their own; and teachers would do well to immerse themselves in the atmosphere of those earlier times, in order to realise more clearly the difficulties which had to be overcome, and by what steps the new knowledge had to be dovetailed in with the old. Moreover, for beginners, the nascent stages of a discovery are sometimes more easily assimilated than the finished product. Beginners need not, indeed, be led through all the controversies which naturally accompany the introduction of anything new; but some familiarity with those controversies and discussions on the part of the teacher is desirable, if he is to apprehend the students' probable difficulties. For though he does not himself feel them now, the human race did feel them at the new fact's first introduction; and the individual is liable to recapitulate, or repeat quickly, the experience of the race.

A large number of people now interested in the most modern developments of wireless have but little idea—perhaps none at all—of the early work, in apparently diverse directions, which preceded and made such developments possible. Even those who are high authorities in wireless telegraphy, and know nearly all that can be known about it—like the distinguished dean of this college, Dr. Eccles—can scarcely know the early stages quite as well as Silvanus Thompson and I knew them; no one, indeed, can afterwards feel in touch with the history so closely as those who have lived through the period covered by it. Only those who have survived the puzzled and preliminary stages of a discovery can appreciate fully the contrast with subsequent enlightenment. It may suffice to say that the term "inductance" or "self-induction," which we now use so glibly, did not at first exist; and that so late as 1888 Sir William Preece still spoke of it as "a bug-a-boo": whereas it is the absolute essential to tuning, and even to electric oscillation. Faraday was the first to direct attention to it, under the name "electrotonic state;" and he treated it experimentally with his usual skill. Lord Kelvin, who first introduced it as a mathematical coefficient, without any explanation, called it "electrodynamic capacity." The name self-induction was given to it by Maxwell, though it was long before it was understood or utilised, and the name "inductance" is a nomenclature of Heaviside.[2]

I wish in this lecture to say practically nothing about anything to do with wireless later than 1896. What I have to deal with is the early pioneering work apart from practical developments. Let me here say at once, to avoid misunderstanding, that without the energy, ability, and enterprise of Signor Marconi, what is now called wireless would not have been established commercially, would not have covered the earth with its radio stations, and would not have taken the hold it has upon the public imagination. Before 1896 the public knew nothing of its possibilities: and for some time after 1896, in spite of the eloquence of Sir William Preece and the demonstrations by Signor Marconi, the public thought it mysterious and almost incredible; and still knew nothing about the early stages. Indeed, I scarcely suppose that Signor Marconi himself really knew very much about them. He had plenty to do with the present; he felt that the future was in his hands; and he could afford to overlook the past.

It may be doubted whether the younger generation, who are so enthusiastically utilising, and perhaps improving, the latest inventions, will care much about the past either. Incidentally, however, I want to say two things to those who are occupied with the subject to-day. First, do not hesitate to speak and think of the *ether of space*, as the continuous reality which connects us all up, and which welds not only us but all the planets into a coherent system. Do not be misled by any misapprehensions of the theory of Relativity into supposing that that theory dispenses with the ether, merely because it succeeds in ignoring it. You can ignore a thing without putting it out of existence: and the leaders in that theory are well aware that for anything like a physical explanation of light or electricity or magnetism or cohesion or gravitation, the ether is indispensable. The ether has all these functions, and many more. We are utilising it every day of our

[1] From the first Silvanus P. Thompson memorial lecture delivered at Finsbury Technical College on February 1.

[2] Silvanus Thompson wrote a pamphlet on the early history of wireless, in connexion with a successful application before Lord Parker for the extension of my fundamental tuning patent of 1897. This pamphlet has never been published, but it ought to be. I had not time to quote from it.

lives; and it would be ungrateful, as well as benighted, if we failed to render due homage to its omnipresent reality and highly efficient properties. It lies at the origin of all electrical developments, and forms the basis for this new and broadcast method of communication.

That is one thing: the second is to congratulate all those whose wonderful and rapid advances have rendered possible the astonishing feat of, in any sense and by whatever means, carrying the human voice across the Atlantic. When Signor Marconi succeeded in sending the letter "s" by Morse signals from Cornwall or Ireland to Newfoundland, it constituted an epoch in human history, on its physical side, and was itself an astonishing and remarkable feat. The present achievement of changing over from Morse signals to ordinary speech, made possible by the valves of Prof. Fleming and Dr. Lee de Forest and others, is a natural though still surprising outcome and development of long-distance transmission, and must lead to further advances, of which at present we can probably form but a very imperfect conception.

Well now, I must go back to very early times. In or about the year 1875 Mr. Edison observed something, which at that time could by no means be understood, about the possibility of drawing sparks from insulated objects in the neighbourhood of an electrical discharge. He did not pursue the matter, for the time was not ripe; but he called it "Etheric Force"—a name which rather perhaps set our teeth on edge;—and we none of us thought it of much importance. Silvanus Thompson, however, took up the matter in a half-hearted sort of way, and gave a demonstration to the Physical Society of London in, I believe, June 1876—a paper which I have had a little difficulty in finding in the Proceedings of that Society. Nothing much came of it, however, though his argument tended to show that the sparks could be accounted for on known principles. The value of this is merely that it must have rendered Thompson susceptible to methods of detecting real electric waves, when they were discovered later.

It was found afterwards that Joseph Henry, at the Smithsonian Institution in Washington, had observed something of the same kind so early as 1842. He seems to have had an intuition of the possible importance and far-reaching consequences of his observation, for he speaks as follows (I quote from a passage cited in my "Modern Views of Electricity," an appended lecture "On the Discharge of a Leyden Jar" [1]):—

"It would appear that a single spark is sufficient to disturb perceptibly the electricity of space throughout at least a cube of 400,000 feet of capacity, and . . . it may be further inferred that the diffusion of motion in this case is almost comparable with that of a spark from flint and steel in the case of light."

That is to say, so early as 1842 Joseph Henry had the genius to surmise that there was some similarity between the etherial disturbance caused by the discharge of a conductor and the light emitted from an ordinary high temperature source.

In the light of our modern knowledge, and Clerk Maxwell's theory, we now know that the similarity is very near akin to identity. Both sources emit ether waves, though prodigiously differing in length.

Subsequent to these early stray observations, a suggestive semi-private observation, of a partially similar kind, was made by that singular genius and brilliant experimenter, David Hughes, the inventor of the microphone or telephonic transmitter, and of the Hughes printing telegraph still used in France. He was a man who "thought with his fingers," and worked with the simplest home-made apparatus—made of match-boxes and bits of wood and metal, stuck together with cobbler's wax and sealing-wax. Such a man, constantly working, is sure to come across phenomena inexplicable by orthodox science. As a matter of fact, Hughes unknowingly was very nearly on the trail of what was afterwards discovered, in a much more enlightened manner, by Hertz. Hughes, too, got sparks in the course of his experiments, but he also got something very like coherer action by means of his microphone detectors. They enabled him to get actual galvanometer deflexions—such as Hertz never got.

I cannot at the moment fix the date, but it was early in the 'eighties and before either Hertz or me. Hughes was a telegraphist, and though he would never have worked out the subject mathematically as Hertz did, and would not have been interested in matters of theory, he might well have stumbled, even at that early date, on something like a rudimentary system of wireless signalling, had he been encouraged. But he was not encouraged. He showed his results to that great and splendid mathematical physicist, Sir George Stokes; and Stokes, alas, turned them down, considering that they were explicable either by leakage or some other known kind of fact.

That is the danger of too great knowledge; it looks askance at anything lying beyond or beneath its extensive scope; whereas an experimenter operating at first hand on Nature may quite well occasionally stumble on a fact which lies outside the purview of contemporary science, and which accordingly neither he nor any one else at the time understands. Crookes himself had a similar experience. In his pertinacious and systematic way he explored many unfamiliar and untrodden regions; and he also invited the attention of Stokes to a simple and easily investigated case of abnormal movement; Stokes, however, perceiving that such motion was physically impossible, declined to take any interest in it or even to see it. His reason told him (and the reason he gave was) that on recognised principles the asserted phenomenon could not happen. But that was precisely its point of interest, and that was why Crookes with his instinctive sagacity conceived that such things held within them the germ of a great science of the future.

In Crookes's case the germ still remains unfructified by orthodox science. In Hughes's case the germ was rediscovered and has borne fruit a million-fold. But this is to anticipate. Suffice it now to direct attention to the collection of Hughes's apparatus now unearthed by the energy and piety of Mr. Campbell Swinton, and exhibited in the Science Museum at South Kensington. Let us try, however, to avoid imitating the mistakes of our revered scientific ancestors: though I admit it is a difficult task. So much rubbish is brought to our

[1] See also NATURE, vol. 39, pages 471-474

notice that we are bound to run the risk of neglecting a jewel among the chaff.

These spasmodic observations, however, are not exactly discoveries: they were more akin to vague intuitions. The first and gigantic step in the real discovery was made by Clerk Maxwell, in or about 1865: and he made it in mathematical form, not in experimental actuality, by one of those superhuman achievements which are only possible to our greatest mathematical physicists. He did not discover either the way to generate ether waves, or to detect them; but he did give their laws: he legislated for them before they were born. He knew the velocity with which they must move, and gave implicitly, though without elaboration, the complete theory of their nature.

Up to his time the nature of light was unknown. All the other theories of light had attempted to explain it on mechanical principles, like the vibrations of an elastic solid. Light was known to consist of transverse waves: the wave-length and the frequency of oscillation could be determined. But no one knew what was oscillating, nor what the mechanism of propagation was. With extraordinary genius Fresnel and MacCullagh had explained the phenomena of light in all detail as regards reflection, refraction, diffraction, interference, and polarisation. But the nature of the waves was unknown; and the elastic solid theory, though fascinating, was felt by those who dived most deeply into it to contain some flaw, and to be, strictly speaking, unworkable. Light did not seem explicable on dynamical principles—the principles which were so fruitfully devised by Galileo and Newton for dealing with ordinary matter.

MacCullagh's theory indeed was not dynamical, and in that respect had some advantage. But it was also vaguer and less definite on that account; though, being thus indefinite and yet enabling results to be achieved, it was less liable to be upset and replaced by future discovery.

To Clerk Maxwell we owe the epoch-making discovery that light was not a mechanical oscillation at all, that the ordinary mechanical properties of matter did not apply to it, but that it was explicable solely and wholly in terms of electricity and magnetism. It is impossible to sum up his discovery in a few words; but roughly we may say that the most obvious outcome was:

(1) That if electric waves could ever be generated they would travel with the velocity of light.

(2) That light was essentially an electromagnetic and not a mechanical phenomenon.

(3) That the refractive index of a substance was intimately related to its dielectric coefficient.

(4) That conductors of electricity must be opaque to light.

Maxwell showed further, though he did not then express it in language of this character, that the ether had two great and characteristic constants, of value utterly unknown to this day, though guessed at by a few speculators like myself;—one of them the electric constant of Faraday called K; the other the magnetic constant of Kelvin called μ. It was impossible then, and it is impossible now—though it is not likely always to remain impossible—to determine the value or even the nature of either of these constants. But Maxwell did perceive a way of measuring their product; and he was the first to measure it. Their product is known; and it is equal—as he showed it must be—to the reciprocal of the square of the velocity of light.

Well now, this great discovery aroused in us young physicists the keenest enthusiasm. In the early seventies of last century—I think about 1871 or 1872—I remember discussing it with the man we all now know and honour, J. A. Fleming, who at that time was a fellow student with me in Prof. Frankland's advanced chemical laboratory at the brand-new College of Science, South Kensington. A year or two later, at Heidelberg, I studied Maxwell's treatise pretty thoroughly, and formed the desire to devote my life if possible to the production and detection of Maxwell's electric waves.

I used to discuss the possibility of producing these waves with my great friend, G. F. FitzGerald, whose acquaintance I made at the meeting of the British Association in Dublin in the year 1878; and he wrote some mathematical papers discussing the possibility of producing such waves experimentally. I myself also spoke at the British Association about them, in 1879, 1880, and again in 1882 at the Royal Dublin Society. FitzGerald, as I say, examined mathematically what then seemed the abstruse question of electric wave production; and after some hesitation came to the conclusion that direct artificial generation of waves was really possible on Maxwell's theory, in spite of certain recondite difficulties which at first led him to doubt it. (See "Scientific Writings" of FitzGerald, edited by Larmor, pp. 90-101.) Indeed one of his papers on the subject was originally entitled "On the Impossibility of Originating Wave Disturbances in the Ether by Means of Electric Forces." The prefix "im" was subsequently dropped; although his first, or 1897, paper concluded thus:

> "However these [displacement currents] may be produced, by any system of fixed or movable conductors charged in any way, and discharging themselves amongst one another, they will never be so distributed as to originate wave-disturbances propagated through space outside the system."

In 1882 FitzGerald corrected this erroneous conclusion, and referred to some early attempts of mine at producing the waves. ("Scientific Writings," p. 100.) I state all this in order to emphasise the difficulty which in those early days surrounded the subject on its theoretical as well as on its practical side.

In 1883, at the Southport meeting of the British Association, FitzGerald took a further step and surmised that one mode of attaining the desired result would be by utilising the oscillatory discharge of a Leyden jar—the theory of the oscillations of which had been worked out, partly by Helmholtz and more fully by Lord Kelvin, 30 years before—if only we had the means of detecting such waves when they were generated.

PRODUCTION OF WAVES.

In 1887 and 1888 I was working at the oscillatory discharge of Leyden jars (initially in connexion with the phenomena of lightning), and—with the assistance of A. P. Chattock—I then found that the waves could be not only produced but also detected, and the wave-length measured, by getting them to go along guiding wires adjusted so as to be of the right length for sympathetic resonance. Thus I obtained the phenomenon of electric nodes and loops, due to the production of stationary waves by reflection at the distant end, and in my own mind thus verified Maxwell's theory. (I gave a brief account of this work, with calculations of wave-length, in *The Electrician* for September 21, 1888, page 623. Many other passages of early history can be found in the same volume about that date. It was an important year.)

Transmission along wires popularly sounds different from transmission in free space, but it was well known to me that the process was the same, and that the waves travel at the same speed, being only guided by the wires, much as sound is guided in a speaking-tube, without the velocity of transmission being to any important extent altered. The theory is given near the end of my paper—an important one as I think, and as Silvanus Thompson agreed—in the *Philosophical Magazine* for August 1888, where the experimental production of much shorter waves is also foreshadowed.

The beginning of my experiments was reported to the Society of Arts in April 1888; they are recorded, as said above, in the *Phil. Mag.*, and they were more completely described orally at the British Association at Bath that year. (See the *Electrician*, vol. 21, pp. 607-8, September 1888.)

In that year, also, I heard for the first time of Hertz's brilliant series of experiments, where, by the use of an open-circuit oscillator, he had obtained waves in free space, and by reflection had also converted them into stationary waves and observed the phenomena of nodes and loops, and measured the wave-length.

Attention was directed to these experiments of Hertz by FitzGerald in his presidential address to Section A of the British Association meeting at Bath in 1888. No wonder they interested him; for they showed that his method of utilising the oscillatory discharge of a Leyden jar was effective; and, to the surprise of all of us, including Hertz himself, that the waves from an opened-out condenser had sufficient power to generate sparks in an insulated conductor upon which they impinged; the detecting conductor, as generally used by Hertz, being in the form of a nearly closed circle with a minute spark gap at which the scintilla appeared. The radiating power of even a small Hertz oscillator was calculated by me in a subsequent paper (*Phil. Mag.* for July 1889, p. 54), and was found to be 100 horse-power, while it lasted. The duration was excessively short, for, at that rate, practically all the energy was expended in a single swing (about the 100-millionth of a second), but its power of producing little sparks was explained.

This work of Hertz was splendid. He was then professor at Carlsruhe, still quite a young man. He had been trained under Helmholtz; and I had made his personal acquaintance in Berlin when I went to call on Helmholtz in 1881, on a tour of the universities of the Continent. He was then Helmholtz's demonstrator, and was thought highly of by that great master. He could speak English, and was very friendly. I did not see him again till some time after the publication of his great discovery.

Hertz was not at that time fully acquainted with Maxwell's theory, although he knew his equations better than any other German except Helmholtz. Maxwell had not then made any serious impression on the Continent. Even Hertz does not seem at first fully to have realised what he was doing, and did not use the words "electric waves." That title was attached to his subsequently translated book at the suggestion of Lord Kelvin. He spoke about the *out-spreading of electric force*; somewhat as Joseph Henry had done. That was the title of his book. He worked out the phenomena he observed with extraordinary skill, both experimentally and mathematically, rapidly perceiving that Maxwell's theory could be applied to them, and that it might be elaborated in detail so as to include the whole of his phenomena. He it was who drew those accurate diagrams of the genesis of the waves, showing what is happening near the oscillator at every phase—diagrams which now appear in most text-books and of which the upper half is represented as scouring across the country. He knew that true waves were not emitted till beyond a quarter-wave length from the source. He knew how they were polarised, and how their intensity differed in the equatorial and polar directions, and how it varied with what may be called latitude. In fact he rapidly came to know all about these waves. As to us, we knew not which to admire most—his experimental skill when working with a tiresome and irritating mode of detection; or his mathematical thoroughness in ascertaining the laws of their propagation. A synopsis of his equations will be found clearly cited in Preston's "Theory of Light," as well as in other books. I translated some of his papers into Nature. Never was there the smallest iota of jealousy between us, or anything but cordial and frank appreciation. Maxwell and Hertz are the essential founders of the whole system of wireless. That is to say, they constructed the foundations solidly and well. Of the super-structure—splendid as it is now—we are as yet far from seeing the completion.

In March 1889 I lectured to the Royal Institution on "The Oscillatory Discharge of a Leyden-jar," and incidentally exhibited many of the effects of waves, both on wires and in free space, with overflow and recoil effects. But there was nothing akin to *signalling* exhibited in this lecture, as there was in the subsequent lecture in 1894.

Nevertheless, Sir William Crookes, on the strength of these experiments—which he mentions—wrote a brilliant article in the *Fortnightly Review* for February 1892 (vol. 51, p. 173) in which he foreshadows actual telegraphic accomplishment by that means, and indicates also the possibility of tuning or selective telegraphy, which was not actually born till 1897. He is evidently impressed with the experiments both of Hertz and of myself, and he quotes from my *Phil. Mag.* paper of August 1888 in confirmation and illustration of his prevision. For he says—after speaking of choosing wave-length with which to signal to specific people—"This is no dream of a visionary philosopher. All the requisites needed to bring it within the grasp of daily life are well within the possibility of discovery, and are so reasonably and clearly in the path of researches now being actually prosecuted in every capital of Europe, that we may any day expect to hear they have emerged from the realm of speculation into that of sober fact." Then he goes on—evidently referring to the experiments of D. E. Hughes, at which he must have been present[3]—" Even now indeed telegraphy without wires is possible within a restricted radius of a few hundred yards, and some years ago I assisted at experiments where messages were transmitted from one part of a house to another, without any intervening wire, by almost the identical means here described."

That article appeared in 1892, and was an anticipation of genius. Too little appreciation is felt to-day for the brilliant surmises and careful and conscientious observations of a great experimental worker like William Crookes; and on some of his researches orthodox science still turns its weighty and respectable back.

OTHER METHODS OF DETECTING WAVES.

In 1889 I had come across the effect of cohesion under electric impetus, and employed it to ring a bell under the stimulus of the overflow of a Leyden jar, as described in my paper to the Institution of Electrical Engineers in 1890 (vol. xix. pp. 352-4, where D. E. Hughes's comment on it is also recorded). In 1893 I heard—through a demonstration by Dr. Dawson Turner at Edinburgh—of Branly's filings-tube—an independent discovery of M. Branly, which really constituted an improvement on the first rough coherer idea. What I had called a coherer was not this, but a needle-point arrangement, or the end of a spiral spring touching an aluminium plate, which was and is extremely sensitive, but rather unmanageable.

With a Branly's filings-tube I made many more experiments, developing the subject; and on the untimely death of Hertz I determined to raise a monument to his memory by a lecture at the Royal Institution on these experiments (Friday, June 1, 1894), which I styled "The Work of Hertz"—meaning that it was a direct outcome and development inspired by that work. I soon found that the title was misleading, so that in the next edition I changed it into "The Work of Hertz and some of his Successors," and afterwards changed it still further into "Signalling across Space without Wires"; for that, of course, is what was being done in laboratory fashion all the time. The depression of a key in one place produced a perceptible signal in another—usually the deflection of a spot of light—and, as I showed at Oxford, also in 1894, employing a Thomson marine speaking galvanometer lent me by Alexander Muirhead, a momentary depression of the key would produce a short signal, a continued depression a long signal;—thus giving an equivalent for the dots and dashes of the Morse code—if the filings-tube were associated with an automatic tapper-back. One form of such tapper-back was then and there exhibited—a trembler or vibrator being mounted on the stand of a receiving filings-tube. This was afterwards improved, with Mr. E. E. Robinson's help, into a rotating steel wheel dipping into oiled mercury. Our aim was to get signals on tape, with a siphon recorder, and not be satisfied with mere telephonic detection. We succeeded; but more rapid progress would have been made had we stuck to the telephone, as wiser people did.

[3] Colonel Crompton now tells me that the experiments to which Crookes was probably referring were conducted not by Hughes but by Willoughby Smith, who seems to have demonstrated that some sort of communication was possible in this way.

TELEGRAPHY 1894 TO 1896.

My Royal Institution (1894) lecture was heard by Dr. Muirhead, who immediately conceived the desire to apply it to practical telegraphy. When my lecture was published—as it was in the *Electrician*, with diagrams roughly depicting the apparatus shown, drawn (some of them) skilfully but not always quite correctly, by the then editor of the *Electrician*, Mr. W. H. Snell—it excited a good deal of interest; stimulating, to the best of my belief, Capt. (now Admiral Sir Henry) Jackson, Prof. Righi, and Admiral Popoff to their various experimental successes which have been elsewhere described.

I was too busy with teaching work to take up telegraphic or any other development; nor had I the foresight to perceive, what has turned out to be, its extraordinary importance to the Navy, the Merchant Service, and indeed Land and War service too. But fortunately in Italy there was a man of sufficient insight to perceive much of this, and with leisure to devote himself to its practical development. In 1896 Signor Marconi came to this country—and the rest is public knowledge.

Man and the Ice Age.[1]

By Prof. W. J. SOLLAS, F.R.S.

THE great advance recently made in our knowledge of the Quaternary epoch begins with the observations of General de Lamothe on the ancient shore-lines which run along the coast of Algeria at heights of about 100, 60, 30, and 20 metres above the existing sea-level. They maintain their course with such remarkable uniformity that M. de Lamothe was unable to regard them as due to elevation of the land, and consequently attributed them to changes in the level of the sea, and was thus led to predict that similar shore-lines would be discovered on the opposite coast of the Mediterranean and particularly in Provence; a prediction which was subsequently verified by Prof. Depéret.

Next Prof. Gignoux, a friend and former pupil of Prof. Depéret, made a detailed investigation of these shore-lines and their associated deposits in the Western Mediterranean, and embodied his results in a masterly monograph.

Finally, Prof. Depéret himself extended these investigations to the Eastern Mediterranean and the west coast of the North Atlantic Ocean. In a comprehensive review of the whole subject he proposed the following classification of the Quaternary deposits, based on the four marine terraces of de Lamothe.

1. SICILIAN (Döderlein). Coast-line at from 90 to 100 m. The most perfect example of this stage is afforded by the Conca d'Oro or basin of Palermo, an ancient bay of the Mediterranean now filled up with Quaternary deposits. They commence with a blue clay containing near its base the famous fauna of Ficarazzo, which points to cold conditions and a depth of 90 metres. Traced towards those localities where the sea was clearer, the clay passes into a Polyzoonal

[1] A lecture delivered to the Geological Society of London on January 10.

limestone resembling our Coralline crag, while towards the shore it becomes sandy. Ascending in the series, the sand increases and finally passes into conglomerates, which at the summit (90 m.) extend over a rocky platform bored by Lithodomus and encrusted with barnacles—to end against the foot of steep cliffs which are undercut and penetrated by sea caves.

The Sicilian stage is sharply marked off from the Calabrian (Upper Pliocene) by a stratigraphical unconformity and a fauna which is distinguished by the disappearance of many Pliocene mollusca, and the advent of many "cold" species from the North Atlantic. These were brought probably by a cold marine current. At Reggio the Sicilian terrace has yielded an entire skeleton of *Elephas antiquus*.

2. MILAZZIAN (Depéret). Coast-line at from 55 to 60 m. The deposits of this stage are chiefly littoral with a fauna indicating a temperate climate, but warmer than that of the existing Mediterranean.

3. TYRRHENIAN (Issel). Coast-line at 28 to 30 m. This includes the well-known Strombus beds (*Strombus bubonius*) which are found all round the Mediterranean. The fauna is characterised by "warm" species, such as still live off the coast of Senegal and the Canary Islands.

4. MONASTIRIAN (Depéret). Coast-line 18 to 20 m. This is named from the city of Monastir in Tunisia, adjacent to a locality very rich in fossils of the stage. The fauna is almost identical with the Tyrrhenian, but on the north coast of the Mediterranean contains no "warm" species.

THE FOUR CORRESPONDING RIVER TERRACES.

General de Lamothe has shown that the four Quaternary beaches or shore-lines of Algeria correspond with the four Quaternary terraces of the river Isser in Algeria, and Prof. Depéret has similarly identified the Quaternary river terraces of the Rhone with the ancient beaches of Provence.

Thus the river terraces were determined by the base level of erosion, *i.e.* in the first place by the position of the sea-level at the time of their formation.

They are thus liberated from their supposed dependence on the four glacial episodes of Prof. Penck. This distinguished investigator had, as is well known, attributed the transport of the material of which they consist to the action of the comparatively feeble rivers which issued from the moraines of the glaciers at their full extension during a glacial episode,—a view scarcely inconsistent with palæontological evidence.

Commont has correlated the four terraces of the Somme with those of the Rhine, and de Lamothe has correlated them with the four Quaternary sea-levels. But the three lower terraces of the Somme, *i.e.* the first or Monastirian, second or Tyrrhenian, and third or Milazzian, all contain in their lowest deposits a warm fauna, which in the case of the lower two includes Hippopotamus—an animal which certainly was not swimming in the Somme at a time when Switzerland and the Baltic buckler were covered with ice and ice was floating in the English Channel. Messrs. Hinton and Kennard have further shown that a warm mammalian fauna characterises the greater part of the terraces of the Thames.

Thus both marine and river terraces unite in proclaiming a warm climate and so far, apart from the Sicilian, we have encountered no signs of an Ice Age.

CONNEXION OF THE TERRACES WITH THE MORAINES.

We turn then to the moraines which afford evidence of the intercalation of glacial episodes in the otherwise genial climate of the Quaternary age. Prof. Depéret considers that he has proof of the association of the Milazzian terraces with the external moraine of the Rhone (Mindel), of the Tyrrhenian with the intermediate moraine (Riss), and of the Monastirian with the internal moraine (Würm). This association by no means implies synchronism, but it enables us to assign the several moraines to their respective stages.

From the point of view we have now reached it will be perceived that the term "Great Ice Age" is a misnomer, and that instead of speaking of a glacial age interrupted by genial episodes, it would be far more in accordance with fact to speak of a genial age interrupted by glacial episodes.

Since these glacial episodes were quite certainly intercalated it will naturally be asked why they are not more obviously represented in the fauna of the Quaternary age. The answer to this is that the remains of a cold fauna are by no means infrequent, but the gravels at the base of a terrace are not the place to look for them. It is to the slopes between the terraces that we should turn, for it is these which correspond with glacial episodes, and when, as generally happens, they are covered with löss we find in it the bones and teeth of such cold-loving species, as we might expect.

It may further be pointed out that terraces, both marine and fluviatile, mark a stationary level of the sea when deposits were accumulating, in which the contemporary warm mammalia might easily be preserved.

In the intervals when the sea-level was changing the work of denudation ruled supreme and undisturbed deposits were formed but sparingly. Now and then no doubt the bones of some animal belonging to the cold fauna might escape destruction and find burial in a marine terrace along with the warm fauna proper to it, and thus possibly have arisen some of those perplexing anomalies of distribution with which we are only too familiar.

REGRESSIONS.

The movement of the sea-level does not appear to have been a simple fall from the Sicilian to the Milazzian

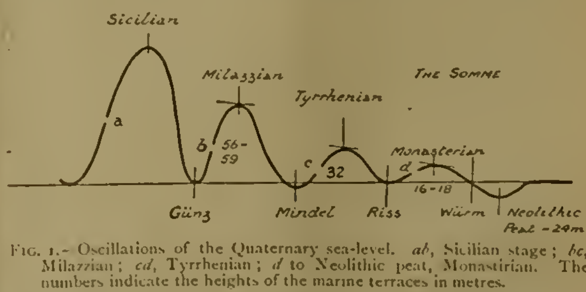

FIG. 1.—Oscillations of the Quaternary sea-level. *ab*, Sicilian stage; *bc*, Milazzian; *cd*, Tyrrhenian; *d* to Neolithic peat, Monastirian. The numbers indicate the heights of the marine terraces in metres.

coast-line and from the Milazzian to the Tyrrhenian; there is evidence to show that it fluctuated (Fig. 1), first sinking from the Sicilian to somewhere not far from the existing sea-level and then rising to the Milazzian, and similarly for all the succeeding stages.

Chronology of the Human Family.

The researches of Mr. Reid Moir have made us familiar with the existence of some member of the Hominidæ in the Red Crag, *i.e.* in the Calabrian stage of the Pliocene system, and if Prof. Depéret is right in referring the Forest Bed to the Sicilian, man seems to be also represented in this stage.

In the Milazzian (third terrace of the Somme) human artefacts are found associated with a warm fauna. Some of them are primitive forms of the Chellean boucher, and the industry as a whole is known as the Strepyan or Pre-Chellean.

The Tyrrhenian (second terrace of the Somme) affords the typical Chellean industry. It was indeed from this stage at Abbeville that Boucher des Perthes obtained the so-called "coup de poing" by which he established for the first time the existence of man at this remote period.

In the Monastirian, represented by the lowest gravels of the first terrace, the Chellean attains its final stage of evolution. It is still associated with a warm fauna. But these gravels are "ravinées" by a later one which brings with it Acheulean implements and the mammoth. If our preceding correlations are correct, the Acheulean must evidently be referred to a later stage of the Monastirian when the Würm glaciation was beginning to make itself felt. The Mousterian and all the succeeding industries of the Upper Palæolithic would then belong to the closing days of the Monastirian and the final retreat of the ice.

The interpretation seems to represent the present state of our knowledge, but it is not without its difficulties; one of the most perplexing is suggested by the "warm" Mousterian of Commont. More than one explanation may be offered of this, but the question may well be left to future research.

Comparison of the Coast-Lines of the Northern and Southern Hemisphere.

A eustatic movement of the sea-level is by itself unproved and unlikely, but a general deformation of the globe might well produce effects involving such a movement. That epeirogenic movements cannot be excluded is shown by the fact that the Tyrrhenian coast-line is deformed by local disturbances so that in the Strait of Messina it stands at 100 m. instead of 30 m., and in the Isthmus of Corinth even reaches 300 m. The Quaternary age was indeed by no means so reposeful as seems to be generally assumed; it includes movements of the earth's crust affecting wide areas and on no inconsiderable scale, as is shown by the recent observations of Prof. Bosworth in Peru, and Dr. Molengraaff in the East Indies.

This immensely complicates our problem. Prof. Depéret has sketched in bold outline a remarkable and suggestive history of the Quaternary age. To work it out in all its details will be the arduous task of more than one generation of geologists.

That a general deformation of the globe was in progress during Tertiary and Quaternary times is suggested by the general presence of raised beaches on both sides of the equator. On the north, General de Lamothe determined the existence of ancient coast-lines in Algeria at 325, 255, 204, 148, 108, 60, 30, and 18 m. On the south, they have been observed in Mejillones Bay, Chile, at 320-300, 225, 133, 111-108, 40, and 15-18 m.

It looks as though the earth accomplished its contraction by pulsations.

Obituary.

Prof. Paul Jacobson.

On January 26 the death occurred at Berlin of Prof. Paul Jacobson, who was widely known as the general secretary of the German Chemical Society and as the editor of important chemical works. He was born on October 5, 1859, at Königsberg in Prussia, and he studied under A. W. Hofmann at Berlin and Victor Meyer at Göttingen. In that university he became a lecturer, and followed Victor Meyer to Heidelberg, where he became professor. Jacobson carried out a number of researches in the field of organic chemistry, especially on azo- and hydrazo-compounds, which earned him the reputation of a careful and original research worker. At the same time he began with Victor Meyer the "Lehrbuch der organischen Chemie," in which these two workers have put on record an immense amount of knowledge and experiences. After the early death of Victor Meyer, Jacobson continued to work alone, unfortunately without being able to finish it.

In 1897 Jacobson removed to Berlin as editor of the Berichte der Deutschen Chemischen Gesellschaft and general secretary of the society. He transacted the business of this society with indefatigable industry and perfect tact until September 1911. He then became scientific editor of the Abteilung für Sammelliteratur, which was founded by the society for the purpose of re-issuing F. Beilstein's "Handbook of Organic Chemistry" and M. M. Richter's "Lexicon of the Carbon-Compounds," and between 1900 and 1906 Jacobson edited five supplementary volumes to the third edition of Beilstein's Handbook. Then he commenced the fourth edition of this standard work, which is to be completed in the near future. The new editions of M. M. Richter have been continued under the supervision of Jacobson by R. Stelzner, as "Literaturverzeichnis der organischen Chemie."

The death of Paul Jacobson will be deeply regretted by all who came to know him in the meetings of the Society and at international congresses. Scientific research suffers a great loss by his death.

Prof. W. N. Parker.

The death occurred on February 22, at the age of sixty-five, at his residence at Cardiff, of Prof. W. N. Parker, emeritus professor of zoology at the University College of South Wales and Monmouthshire.

Prof. Parker was a pupil of Huxley and for a time acted as his demonstrator. During 1881 and 1882 he was lecturer in biology at University College, Aberystwyth. He joined the staff of the University College of South Wales and Monmouthshire when it opened its doors in 1883, and retired in September 1922. He came of an illustrious family, being a son of the late Prof. W. K. Parker, and a brother of the late Prof. T. J. Parker. He married a daughter of the late Prof. August Weismann, who survives him, and leaves a family consisting of a son and two daughters.

Prof. Parker was for many years president of the biological section of the Cardiff Naturalists' Society and a member of the science committee of the National Museum of Wales. To the latter institution he presented a valuable collection of zoological material a few months prior to his death. In collaboration with his brother he wrote Parker and Parker's "Practical Zoology." He also translated into English Weismann's "Germ Plasm" and an abbreviated form of Wiedersheim's "Vergleichende Anatomie der Wirbeltiere." In addition, he published original papers on the following subjects: "Anatomy and Physiology of Protopterus," "Poison-organs of Trachinus," "The Structure of the Young of *Echidna aculeata*," "Persistence of the Left Posterior Cardinal Vein in the Frog, with Remarks on the Homologies of the Veins in the Dipnoi," "The Respiratory Organs of Rhea," "On some Points in the Anatomy of the Indian Tapir (*Tapirus Indicus*)," "The Anatomy of the Cæcum in the Rabbit (*Lepus cuniculus*) and Hare (*Lepus timidus*)"; in collaboration with F. M. Balfour, "On the Structure and Development of *Lepidosteus*"; and in collaboration with T. H. Burlend, "On the Efferent Ducts of the Testis in *Chimæra monstrosa*."

Prof. Parker devoted himself for nearly forty years to the interests of the College and University and to the development and organisation of the zoological department. It is impossible to speak too highly of the courage and determination which he brought to bear upon his work in the face of great difficulties in the early days of the College. He will be sadly missed by a large body of former students who passed through his hands, in whose personal welfare, both in the department and outside, he always took the keenest interest. The news of his death will be received with great regret by a large circle of friends and former colleagues.

J. H. L.

Mr. F. J. Lloyd.

The death of Mr. Frederick James Lloyd on February 8 removes an interesting figure from the ranks of the older workers in agricultural science in this country. Mr. Lloyd was born at Sketty, near Swansea, in 1852, and was educated at Bristol Grammar School. After leaving school he proceeded, for family reasons, to study law, but, showing a natural aptitude and interest in science, he soon rejected a legal career and found an opening in the laboratory of the late Dr. Voelcker. The training received there during the next four years was supplemented by evening studies at King's College, London, and subsequent experience in chemistry during a sojourn in Germany. On his return to England he became successively chief assistant to Dr. Thomas Stevenson, of Guy's Hospital, and at the laboratory of the Royal Agricultural Society, ultimately setting up in practice on his own account as an agricultural chemist.

Mr. Lloyd's knowledge of physiology and agricultural chemistry thus acquired led him naturally to a special interest in the subject of dairying, with which he became still more closely identified on the death of Dr. Voelcker by his appointment as consulting chemist to the British Dairy Farmers' Association. His close connexion with that body lasted throughout his life and directed his attention to questions of milk production and the feeding of dairy stock in relation thereto. In due course he began a series of investigations on the manufacture of Cheddar cheese, undertaken on behalf of the Bath and West and Southern Counties Agricultural Society, which proved very helpful to cheese-making farmers of the West of England and brought him into contact with the special agricultural interests of that area. Cider-making particularly attracted his notice. In association with Mr. Neville Grenville, and again on behalf of the Bath and West Society, he started experiments designed to improve the methods of manufacture then current on farms. These extended over some ten years and resulted in the establishment of the National Fruit and Cider Institute at Long Ashton in 1903, Mr. Lloyd acting as director until 1905. This Institute, now associated with the University of Bristol, and serving as its Agricultural and Horticultural Research Station, has been developed by the Ministry of Agriculture to function as the senior Fruit Research Station for this country, and stands as a direct result of Mr. Lloyd's work.

Mr. Lloyd lived also to see the establishment of the Research Institute for Dairying at Reading. His pioneer studies on both the subjects with which he was so closely identified have thus found fitting recognition.

Much of Mr. Lloyd's work was published by him in the form of a series of reports in the Journal of the Bath and West Society, of which for some twenty years he was associate editor. Those relating to cider were republished later by the Ministry of Agriculture. He also, while holding an appointment as lecturer on agriculture at King's College, London, published his lectures in book form under the title of "The Science of Agriculture," a volume which has been translated into several languages.

We regret to announce the following deaths:

Prof. A. S. Butler, lately professor of natural philosophy in the University of St. Andrews, on March 2, aged sixty-eight.

Sir Ernest Clarke, until 1905 secretary of the Royal Agricultural Society of England and the first lecturer in agricultural history in the University of Cambridge, on March 4, aged sixty-seven.

Prof. B. E. Fernow, emeritus professor and dean of the faculty of forestry at the University of Toronto, and first chief forester of the United States, on February 6, aged seventy-two.

Prof. G. Lefevre, professor of zoology in the University of Missouri, on January 24, aged fifty-nine.

Prof. Vladimir M. Shimkevich, professor of zoology in the University of Petrograd.

Rev. William Wilks, for twenty-five years secretary of the Royal Horticultural Society and the producer of the well-known Shirley poppies, on March 2, aged seventy-nine.

Current Topics and Events.

MUCH excitement was recently created all over the world by the sensational headline, "Cause of influenza discovered at Rockefeller Institute, says Dr. Flexner." The announcement was given a prominent position in the daily papers and everywhere was lauded as one of the greatest medical discoveries known. Almost alone among our contemporaries we stated the actual facts of the work of Olitsky and Gates, the reputed discoverers of the long-sought-for microbe of influenza, and we recommended the adoption of a cautious reserve until further data were revealed. Some of the inner history of this latest American press boom are now published in an editorial in the *Journal of the American Medical Association* (February 10), which has the greatest circulation of the medical papers of the United States and is a journal of the highest repute. It seems that after the sensational announcement above, the *Journal* telegraphed to Dr. Simon Flexner, who replied that his announcement was merely a summary of papers already published by Olitsky and Gates in the ordinary way in the *Journal of Experimental Medicine*. The summary was prepared for the New York State Department of Health. Dr. Flexner states that some one in the State publicity department had headlined the summary without his knowledge. Now that the actual statement of Dr. Flexner has appeared in the Health News Service, it is seen to be nothing that has not been known for the last three years, and as the *Journal of the American Medical Association* points out, the "organism cannot be said to have been conclusively shown to be the cause of the condition known as epidemic influenza," a view which we ourselves independently printed. In justice to the Press it is stated that in this instance it was not to blame, but it is not stated who was. The *Journal* deprecates this method of publication, leading as it does to false hopes for thousands of sufferers, and to the ultimate discredit of real advances in medical science.

TELEGRAMS from New York appeared in several newspapers of February 28, announcing the discovery of a fossilised human skull in the province of Santa Cruz, Patagonia. The *Times* of March 1 published particulars relating to the skull, which were obtained by its correspondent at Buenos Ayres from the discoverer, Dr. Wolf, formerly of the Canadian Geological Survey. The skull, it appears, was found not by Dr. Wolf but by a settler seven years ago in sand-hills in the pampas lying some twenty miles to the west of the port of Santa Cruz. The discoverer reports it to be "petrified" and "probably of tertiary origin." As regards its characters, all that is to be learned is that it is "long in proportion to its width," that its "frontal eminences are well marked," and that it may be a woman's skull. It is true that there exist in Patagonia deposits of the right age to yield fossil remains of Pliocene man, and on numerous occasions, during the past twenty-five years, claims of his discovery have been made. None has stood the test of inquiry; when the remains proved to be human, it was found that a mistake had been made concerning their geological antiquity; when their antiquity was upheld, the remains proved not to be human. Whether the discovery now announced will prove an exception remains to be seen.

IT is reported that excavations now being carried on at Ur of the Chaldees on behalf of the British Museum and the University of Pennsylvania have brought to light a temple of the Moon God. As Ur was the seat of the worship of deified kings and one of the greatest centres of ancient theology, its further investigation is likely to add considerably to our knowledge of the religious and social life of early Mesopotamia. The site and the purpose of the temple were first identified through the interpretation by Rawlinson of four cylinder seals discovered in 1854 by J. E. Taylor, who located the temple tower and excavated an adjacent building and burial mound. Further excavations were carried out by Mr. R. Campbell Thompson in 1918 and by Dr. H. R. Hall, on behalf of the Trustees of the British Museum, in 1919. Dr. Hall also investigated a neighbouring site at Tell el-Obeid, where he found much copper, including several lion heads and a large relief, in a pre-Sargonic building (*circ.* 2900 B.C.) beneath a platform of unburnt brick, probably of Dunghi of Ur (*circ.* 2450 B.C.). The site of Ur itself was occupied from neolithic down to quite late times, the temple having been restored by Nabonidus in the sixth century B.C. As regards its early inhabitants, Mr. Campbell Thompson, in the *Times* of March 1, points out that the present excavations may be expected to throw light upon his suggestion that the people of this area differed in race from the Sumerians. This view is based upon the character of the fragments of hand-made, painted pottery found by himself and Dr. Hall at Ur, Eridu and Tell el-Obeid, which is identical with that discovered by de Morgan at Susa in Elam. This latter, in turn, is referred to a similar, but rougher, type found at Anau in Turkestan.

A WELL-PRESERVED dolmen has been discovered by workmen while excavating at the back of a house at St. Ouens, Jersey. Associated with the dolmen was a kitchen midden full of limpet shells and containing an ancient human skull and a round stone for grinding corn. The skull is very much flattened in the frontal region, and it is no doubt on this ground that a very high antiquity, exceeding that of *Pithecanthropus erectus*, has been attributed to it locally, as is stated in a highly coloured report which appeared in the *Daily Mail* of February 26. It is also suggested that the kitchen midden is of mesolithic age. Although the find is of considerable interest, neither supposition appears to be well founded. Shell-fish must always have been, as they are still, an important element in the diet of the islanders, and therefore does not necessarily indicate a mesolithic culture, while the association with the dolmen and a stone for grinding corn would suggest that a very early date in the neolithic period for the skull is not probable. The flattened appearance of the skull, upon which stress is laid in the report of the discovery, may be due to pathological causes, but more probably is, as often happens, a case of flattening due to post-mortem pressure after burial. Further details of the measurements of the skull will be awaited with interest, as it will be important to note whether, notwithstanding its distortion, it is to be ascribed to the Mediterranean long-headed type.

On February 12, Prof. Otto Pettersson, director of the Swedish Hydrographic Biological Commission, Gothenburg, celebrated the seventy-fifth anniversary of his birth, and both chemists and oceanographers in this country, to whom his genial personality is so well known, will wish to join in offering him their congratulations and their good wishes for his future prosperity. Having in early life made a European reputation as a chemist, Prof. Pettersson turned his attention to the study of oceanography, and much of the work in that subject during the last thirty years has owed its success to his initiative and inspiration. His name is particularly associated with the foundation in 1902 of the International Council for the Study of the Sea, of which organisation he was president for a number of years. It was largely owing to Prof. Pettersson's influence and efforts that the Council survived the trying period of the European war and has since renewed and extended the valuable co-operative researches which it is conducting in the interests of the fisheries. We rejoice to know that in spite of his advanced age, Prof. Pettersson's zeal for scientific work is in no way abated, and that he remains an active and energetic investigator, more especially of problems affecting the sea.

The sixth Silvanus Thompson memorial lecture of the Röntgen Society is to be delivered on Tuesday, May 1, by Dr. C. Thurston Holland.

The gold medal of the Astronomical Society of the Pacific was presented to M. B. Baillaud, director of the Paris Observatory, at the American Embassy in Paris on February 26.

Dr. Christopher K. Ingold was awarded the Meldola medal of the Institute of Chemistry, for the second time, at the annual general meeting of the Institute held on March 1.

An excursion to Devizes and Salisbury Plain, extending from May 18 to 21 inclusive, particulars of which are obtainable from Mr. B. H. Cunnington, Wiltshire Archæological Society, Devizes, has been arranged by the Prehistoric Society of East Anglia.

The Medical Research Council has appointed the following scientific committee to organise an investigation into dog's distemper: Sir William B. Leishman (chairman), Mr. J. B. Buxton, Capt. S. R. Douglas, Prof. F. Hobday, and Dr. C. J. Martin. A member of the Council's staff will act as secretary to the committee, and communications should be addressed to the Secretary, Distemper Research Committee, 15 York Buildings, Adelphi, W.C.2.

The British Association recently acted in co-operation with a number of other "travelling" societies in requesting the railway companies to revert to the pre-war practice of granting return tickets at single fare and one-third to members attending meetings, on presentation of a voucher. The Association has now been informed that in connexion with its next annual meeting, in Liverpool, September 12–19, this concession will be made by the companies.

At the meeting of the Franklin Institute of the State of Pennsylvania, Philadelphia, held on February 21, Dr. Lee de Forest received the Elliott Cresson gold medal awarded to him by the Institute for his invention of the three-electrode audion. In presenting Dr. de Forest for this award, his invention was characterised as one of the most important ever made in the field of the electrical transmission of intelligence, and one which through its development has marked a profound revolution in the art of radio communication.

The tenth annual general meeting of the Institution of Petroleum Technologists will be held at the House of the Royal Society of Arts on Tuesday, March 13, when an address will be delivered by Prof. J. S. S. Brame, the retiring president. The president-elect for the ensuing session is Mr. Herbert Barringer, and the vice-presidents are Mr. Alfred C. Adams, Sir George Beilby, Sir John Cargill, Viscount Cowdray of Cowdray, Mr. Arthur W. Eastlake, and Sir Thomas H. Holland.

At the annual general meeting of the Optical Society, held on February 8, the following officers and council were elected: *President*: Prof. A. Barr. *Vice-Presidents*: Sir Frank Dyson, Mr. T. Smith, and Mr. R. S. Whipple. *Hon. Treasurer*: Maj. E. O. Henrici. *Hon. Secretaries*: (*a*) Business Secretary, Prof. Alan Pollard, Imperial College of Science and Technology, South Kensington, S.W.7; and (*b*) Papers Secretary, Mr. F. F. S. Bryson, Glass Research Association, 50 Bedford Square, W.C.1. *Hon. Librarian*: Mr. J. H. Sutcliffe. *Editor of Transactions*: Dr. J. S. Anderson. *Council*: Dr. J. S. Anderson, Instr.-Comdr. T. Y. Baker, Mr. W. M. Brett, Prof. F. J. Cheshire, Mr. R. W. Cheshire, Dr. R. S. Clay, Mr. H. H. Emsley, Mr. P. F. Everitt, Dr. J. W. French, Miss L. M. Gillman, Mrs. C. H. Griffiths, Dr. L. C. Martin, Prof. A. W. Porter, Mr. F. Twyman, and Mr. A. Whitwell.

A new meteorological observatory at Santa Cruz, Teneriffe, Canary Islands, was sanctioned by Royal Decree in July 1921. It is now announced that the building has been started, and will probably be completed shortly. The fact is noted in the *Meteorological Magazine* for February, and it is stated that the Island of Teneriffe already has a first-class observatory at Izana, situated 2307 metres above sea-level. Being on the direct route from Lisbon to Rio de Janeiro, these two observatories will be of great service to transatlantic aerial navigation. The note adds that a hydroplane station is also to be established on the island.

A memorandum on the probable character of the weather in north-west India in January, February, and March 1923 was prepared by Dr. G. T. Walker, director-general of Indian observatories, and submitted to the Government of India on January 5. The data which control the amount of rain and snow to be expected are:—(*a*) The recent weather conditions in Persia and north-west India; these are slightly favourable. (*b*) The seasonal change in the upper air in northern India, which is slightly adverse. (*c*) The atmospheric pressure over India in the previous October and November, which is neutral, October being above normal and November below normal. (*d*) Rainfall at Seychelles and Zanzibar; rainfall at Seychelles was in defect in November and December, and at Zanzibar it was in excess in December. On the whole the indications point to a slight defect in the winter precipitation, but the indications are said not to be sufficiently pronounced to justify a forecast of a deficiency.

Referring to the obituary notice of Prof. George Lunge in Nature of February 17, p. 228, a correspondent has pointed out the last paragraph might give the impression that Dr. Hurter was of German nationality whereas he was a native of Schaffhausen, Switzerland. The writer of the notice was concerned rather with the influence exercised at the time by the German universities in providing opportunities, not necessarily for Germans alone, for scientific training as chemists, some of whom came to England to acquire knowledge and experience of the practical applications of the science.

We have received from Messrs. A. Gallenkamp and Co. a catalogue of "Electrometric Apparatus for determining Hydrogen Ion Concentrations." This includes an apparatus for determining hydrogen ion concentrations both for work of high accuracy and for routine industrial work.

Messrs. Bowes and Bowes, 1 Trinity Street, Cambridge, have just issued a very useful catalogue (No. 417) of second-hand books, journals, and portraits of scientific interest offered for sale by them. It contains 1158 titles, which are classified under the following headings: Journals, etc.; Agriculture; Anthropology and Ethnology; Biography; Biology; Botany (including Forestry and Gardening); Geology; Microscopy; Zoology (including Ornithology and Entomology); General Science; Chemistry; Physics (including Einstein Theory); Medical (including Physiology); Portraits.

Our Astronomical Column.

Increase of Brightness of Beta Ceti.—There appears to be no reason to doubt the news that this star has brightened by more than a magnitude in the last week or so. The change was first observed by a British schoolboy named Abbott, resident in Athens; being a member of La Société Astronomique de France, he telegraphed to M. Camille Flammarion at Juvisy, whose assistant, M. Quénisset, confirmed the brightening. Apparently further confirmation has been received from the United States. Unfortunately the star is observable in England only by day or in very bright twilight, and the skies have not been propitious for studying it. Data for drawing the light curve are not yet to hand, so that it is premature to speculate on the probable cause of the increase of light. The news hitherto available comes through the daily press; the Astronomical Bureau at Copenhagen has made no communication.

The Zodiacal Light.—Mr. W. F. Denning writes:—During the period from about March 8–20 and April 4–18, the zodiacal light may be well observed on clear evenings in the absence of moonlight. It will be visible about two hours after sunset as a faint glow extending upwards, obliquely, through the constellations of the Zodiac, and broadest at its base on the western region of the horizon. It apparently varies from night to night, for its visibility is evidently influenced by atmospheric conditions. Careful observations of the degree of luminosity, positions, and boundaries of the light on successive evenings will be valuable. The most probable explanation of the phenomenon is that it is due to the sun's reflected light on myriads of meteoric particles belonging to systems of little inclination and situated at moderate distances from the sun.

The Spectra of Visual Double Stars.—Mr. F. C. Leonard publishes in the Lick Observatory Bulletin (No. 343) an important contribution to the study of the spectra of visual double stars. If the components of a double star had a common origin, a knowledge of the spectral relationships existing in different systems, presumably at various stages in the course of evolution, might be expected to disclose the general trend and the comparative rates of development of these stars. It was with the intention of gaining more knowledge on this subject that Mr. Leonard commenced this investigation in 1920. From a study of eighty visual double stars specially observed for this work, he finds that the spectrum of the secondary component of a dwarf star is generally of a later class and that of a giant star is of an earlier class than the primary. In both giant and dwarf stars the greater the difference in magnitude between the primary and secondary the greater is the absolute difference in spectral class.

The spectrum of each component of a double star appears to be a function mainly of its absolute magnitude; or in other words, the spectra of the components of double stars are so related to each other that, with but few exceptions, these systems conform to the Hertzsprung-Russell arrangement for individual stars, plotted according to spectral class and absolute magnitude. In this configuration, the fainter component normally precedes the brighter one, regardless of whether the latter be a giant or dwarf in the order prescribed by the Lockyer-Russell theory of stellar evolution. The two earlier conclusions are special phases or necessary consequences of this generalisation. Thirteen binary systems, all stars of which were dwarfs, indicated that as the sum of the masses of the components increased, their disparity in spectral class approached zero. Of any two stars of unequal mass but of otherwise identical physical properties, that with the less mass will in general pass through its life history in advance of the more massive one.

Research Items.

The Oldest Christian Tomb in India.—Agra, which possesses, in the splendid mausoleum known as the Taj, one of the finest sepulchres in the world, claims also the oldest Christian grave in northern India. It is known as the Martyr's Chapel, the tomb of a rich and very pious Armenian merchant called Martyrose, who died at Agra in A.D. 1611. The inscription on the tomb, now for the first time translated by Mr. Mesrovb Seth in the Journal of the Asiatic Society of Bengal, vol. xvii., 1921, runs: "In this tomb rested the pilgrim Martyrose son of Pheerbashi of Julfa. He died in the city of Agra and gave his goods to God for his soul. 1060 of the Armenian era." The Archæological Department has now restored the tomb of this worthy, a member of the important Armenian community of Julfa in Persia, who came to India as a merchant. An inscription in Persian to his memory has been placed on the tomb.

The Ismaili Sect of Islam.—The important sect of the Ismailis or Assassins, the doctrines of which were preached by the Old Man of the Mountain, has exercised wide influence in Persia. The scattered material collected by historians, travellers, and theologians cannot compare in value with the genuine documents of the sectarian literature, but for five hundred years, when these materials came to an end at the time of the Mongol invasion which destroyed the power of the Assassins, the life of the sect is a blank. Mr. W. Ivanov, who has spent seven years in investigating the beliefs of the sectarians in Persia, has published under the title of "Ismailitiia," a translation of an important text which throws much light on the subject. This has been issued by the Asiatic Society of Bengal as part 1, vol. viii. of its memoirs. It will be interesting to European readers, as the leader of the sect is the Agha Khan of Bombay who did notable service to the Indian Government in the War, and has since devoted himself to the task of calming the agitation which has arisen in India on the Caliphate question.

The Indian Tribes of California.—The University of California, in its series of publications on American archæology and ethnology, has issued a large number of valuable memoirs, but a general survey of the inter-relations of the culture of these tribes has hitherto been wanting. This want has now been supplied by Mr. A. L. Kroeber, an ethnologist to whom we owe several of these tribal memoirs, who has prepared a general sketch under the title of "Elements of Culture in Native California," for the University series (vol. xiii. No. 8), in which he describes the arts of life, social organisation, religion, and ceremonies. This memoir, which gives an excellent survey of the industrial, social, and religious life of a primitive people, will be a valuable book of reference to ethnologists. It is provided with sketch maps, but unfortunately a general index is wanting.

Microbic Transmissible Autolysis.—One of the most interesting developments of modern bacteriology has been in relation to what is now called the Twort-d'Hérelle phenomenon. This has recently been the subject of the Cameron prize lecture given by Prof. J. Bordet, of Brussels, and published in the *Brit. Med. Journal* of February 3. In this lecture the main facts are clearly set forth and particularly the views of Bordet and his co-workers. For those who have not been following the subject specially it may be stated that in 1915, F. W. Twort, Director of the Brown Institution, London, described a peculiar glassy-like change which appeared in colonies of certain micrococci which he had isolated from calf lymph. A minute trace of the glassy agent added to a cultivation of bacteria dissolved the latter, and strange to say, the glassy agent could traverse fine porcelain filters without detriment. In 1917 d'Hérelle observed similar phenomena and regarded them as due to the activity of a living agent which he called "microbe bacteriophage" on account of its power of devouring bacteria. This view he has continued to defend with great vigour. Bordet and Ciuca adopted an entirely different explanation. They do not believe the active substance is a living agent at all but as a product of the bacterium itself induced in the first instance by some external influence and subsequently capable of indefinite transmission. A full treatment of the subject will be found in Bordet's lecture referred to above.

The Spleen.—The functions of this organ are somewhat obscure. It is generally recognised, however, that it has something to do with the destruction of effete red blood corpuscles. A certain proportion of the corpuscles in general circulation are more fragile than the rest, in the sense that when distended by osmosis in hypotonic solutions they burst in solutions of a higher concentration than do the younger, more distensible ones. A recent paper by Bolt and Heeres, in the *Biochemical Journal*, vol. 16, p. 754, shows that after passing through the spleen, blood corpuscles are rendered less resistant, so that a larger proportion become hæmolysed when placed in the stronger salt solutions, that is, the less hypotonic solutions. Thus they withstand distension to a smaller degree than normally. This property is due to the adsorption of some substance supplied by the spleen and can be removed by washing with Ringer's solution. The previous work of Brinkman and van Dam had shown that the fragility of red corpuscles depends on the relative proportion between cholesterol and lecithine in their outer membranes, the former conferring stability, the latter, fragility. Apparently the spleen adds lecithine in larger amount than it does cholesterol.

Curing Sleeping Sickness.—In the *Empire Review* for February Dr. Andrew Balfour has an interesting article entitled "Cure of Sleeping Sickness." He deals largely with the claims of the new German remedy "Bayer 205" and admits that it is the most powerful destroyer of the parasites of the disease so far tested. For a time sleeping sickness and other trypanosome diseases were looked upon as absolutely fatal, while later on partial success was achieved by more than one remedy containing arsenical or antimonial bodies. "Bayer 205" contains neither of these in any form, and although its exact composition is not known, it is suggested that it belongs to the benzidine dye series. It is a white powder, easily dissolved in water, neutral in reaction, without smell, and does not deteriorate on heating. It possesses extraordinary parasitotropic action on trypanosomes, and in minute doses can produce a *sterilisatio magna* in animals heavily infected with these parasites. These results worked out by Haendel and Joetten have been confirmed in man by Mühlens and Menk in Germany and by Wenyon and Manson Bahr in London. Dr. Balfour emphasises the need for chemical research in this country, and lays stress on the necessity for persistence, time, money, and far-sightedness. Ehrlich was fond of summing up the success of scientific researches in what he termed the four G's, *Geld, Glück, Geduld, Geschick*, which comes to the same thing.

RECENT PENTACRINIDÆ.—In the Journal of the Washington Academy of Sciences of January 4 Mr. A. H. Clark publishes a revision of the recent representatives of the crinoid family Pentacrinidæ. For many years the name Pentacrinus has ceased to be applied to any crinoid now living, and now Isocrinus, to which genus most of the modern species were for a time referred, is also considered to be entirely extinct. For the only species that remained—the Atlantic *Pentacrinus wyville-thomsoni*—Mr. Clark founds the new genus Annacrinus.

A NEW BRITISH ENTEROPNEUST.—In the current number of the *Quarterly Journal of Microscopical Science* (vol. 66, part iv.) Prof. Alexander Meek records the discovery of an interesting addition to the British marine fauna. The Enteropneusta have hitherto been represented in British seas, so far as known, only by two species of the genus Dolichoglossus, from the west coast of Ireland and Scotland respectively. The newly discovered species is apparently referable to the genus Glossobalanus, and the name proposed by Prof. Meek is *Glossobalanus marginatus*, the species being regarded as distinct from any previously described. Unfortunately only a single imperfect specimen was obtained, off the coast of Northumberland at a depth of 52 fathoms. It is further suggested that a Tornaria larva sometimes met with in the North Sea plankton may be referable to this species.

POMOLOGY.—A few years ago Mr. E. A. Bunyard, of the well-known Maidstone nurseries, upon his own initiative started a *Journal of Pomology*, in which contributions of very great scientific interest have been published. With its third volume this journal commences its career anew as the *Journal of Pomology and Horticultural Science*, with a powerful publication committee to support the original editor, the financial responsibilities now being transferred to the three horticultural research stations at Long Ashton near Bristol, Cambridge, and East Malling, Kent. In a foreword, Sir A. D. Hall expresses his interest in the new journal and his hope that while providing a medium for the publication of the results obtained by the investigators at these research stations, it may also "gather together new knowledge and experience from all kinds of public and private workers connected with fruit-growing in Great Britain." From the beginning the format of the journal has been good and many of its photographic reproductions exceptionally fine. The first number of the new volume contains a valuable series of papers upon the raspberry. The genus Rubus has long been a stumbling-block to systematists, and Mr. N. H. Grubb appears to have commenced for *Rubus Idæus* the task which the late Rev. Moyle Rogers carried out so thoroughly for *Rubus fruticosus*. Upon a series of characters the large and confusing number of varieties of raspberry grown in Great Britain are arranged within groups and a key given to permit the determination of some of the more important varieties. First importance is attached to the surface characters of the young canes, which fall into two groups, one pubescent, the other glabrous or nearly so; the colours of the spines then provide another valuable character. This important work is certainly a necessary preliminary to any cultural or experimental work with the raspberry. W. Boyes describes the characters of different types of apple-tree shoots, based largely upon the current nomenclature of the French horticulturist. F. V. Theobald describes the apple and plum case-bearer and its treatment. Herbert W. Miles discusses the control of the apple-blossom weevil, and G. S. Peren the value of spraying for the control of the logan beetle.

SURVEYS IN THE EASTERN KARA-KORAM AND KHOTAN.—A detachment from the Survey of India, under Maj. H. Wood, was attached to Dr. F. de Filippi's expedition of 1913 to undertake exploration and geophysical researches in the little-known regions of the Kara-koram at the headwaters of the Shyok and Yarkand rivers. Maj. Wood's report, which was delayed by the war, is now published ("Exploration in the Eastern Kara-koram and the Upper Yarkand Valley. Dehra Dun: Office of the Survey, 1922. 6*s*.). The work included the survey of the Depsang plateau, the San Remo Glacier, from which the River Yarkand proves to drain, and the upper valley of that river. Maj. Wood shows how he ascended what he believes to be the line of an old route leading across the head basin of the Oprang, but Dr. Filippi was forced to abandon his project of exploring that valley. An appendix contains a discussion of historical evidence bearing on certain disused or forgotten routes through the Kara-korams. The report is accompanied by a series of photographic plates and a coloured map, on a scale of 1 to 250,000, of the area surveyed by Dr. F. de Filippi's expedition.

MAN AS AN AGENT IN GEOGRAPHICAL CHANGE.—Some of the ways in which man modifies the surface features of the earth were discussed in a lecture by Dr. R. L. Sherlock, given to the Royal Geographical Society on February 19. Mining and quarrying assist the natural agents of denudation and transform scenery. A calculation of the amount of rock removed in various kinds of excavation by man in Great Britain since the earliest times shows the significance of this work. The total excavation spread over the British Isles would amount to 3·83 inches. This may be compared with Geikie's estimate of the rate of erosion in the British Isles, which is 2·72 inches in 2000 years. Surface subsidence is an important effect of mining operations. Dr. Sherlock showed how this might be prevented or delayed by leaving pillars to support the roof, or by the method frequently adopted in the collieries of Upper Silesia of stowing waste materials in the cavities produced. The accumulation of waste on the surface may be utilised to fill up a foreshore as at Middlesbrough, where 4270 acres have been reclaimed in this manner; or it may form artificial hills. In the Black Country of Staffordshire some 230 million cubic yards of waste have been deposited on 23 square miles. Yet in this case subsidence has probably more than counterbalanced the gain. Under the site of London some 50 million cubic yards have been excavated, but brick or other linings have prevented subsidence. In fact, the level of London has actually risen by the accumulation of domestic and other waste. Excavations have shown this to be the case. On its own debris the height of London grows about one foot a century. It is probable that in three centuries the waste from the coal used in London has amounted to more than 42 million tons. Most of this directly, or indirectly, in the form of bricks and artificial flagstones, has been incorporated in the site of London. Dr. Sherlock also gave examples of man's interference with rivers, and, by means of pumping, with the circulation of underground waters.

OIL IN LACCOLITHIC DOMES.—Of the many geological structures in which petroliferous sediments may be involved, elevated, dome-like masses of rock, resulting from igneous intrusion of the laccolithic type, are rarely productive of oil on a commercial scale, save possibly in certain cases in Mexico. There is, however, no reason *prima facie* why such a structure should not be favourable, unless secondary mechanical or thermo-dynamical effects on the superincumbent strata seriously influence the stability of organic material within the sediments. Thus it is not surprising to find that the United States Geological Survey is turning its attention to such possibilities in certain areas in the Western States, and a brief paper (Bulletin 736-F) dealing with oil accumulation in laccolithic domes in the Little Rocky Mountains region of Montana (the work of Messrs. A. J. Collier and S. H. Cathcart) is one of the first results of this inquiry. In the cases described, the uplifts are due to intrusions of porphyry, some of which are exposed, others, in the less denuded tracts of country, being still covered by sediments of varying ages, principally Upper and Lower Cretaceous. Of the former, the Eagle sandstone and the Mowry shale are both possible oil-bearing horizons, while the Kootenai formation (Lower Cretaceous) is well known to be favourable elsewhere. One or other of these horizons could be reached by drilling in at least two pronounced domes, the Guinn and the Grouse-Alder domes, within the area described, to the south of the Little Rocky Mountains. The authors do not of course prophesy commercial success for any fields which may be opened up here, but they have indicated the most likely areas in an otherwise discouraging region, and it will be interesting to observe, both from the scientific and industrial points of view, the results of any trials which may ultimately be made as a consequence of their report.

Lighting in Mines.—A striking illustration of the value of good illumination in enabling output to be increased in industrial operations is afforded by some experiments in coal mines described by Messrs. E. Farmer, S. Adams and A. Stephenson in the Journal of the National Institute of Industrial Psychology. The report of the Miners' Nystagmus Research Committee, issued last year, confirmed the impression that this disease is due mainly to inadequate illumination. The present research shows how the miner's work is hampered and his output affected by deficient lighting. There are two chief drawbacks to most existing miners' lamps, the low illumination afforded and the exposure of the filaments, which, in such dark surroundings, give rise to highly inconvenient after-images on the retina. The authors describe a form of cylindrical shield which has a useful effect in avoiding this form of glare, and also give the results of work for an eight-hour period with the ordinary standard miners' lamp and with a special "porch-light" giving six times as great an illumination. It was shown that the improved illumination led to an increase in output from 2·47 to 2·83 tons, an increase of 14·57 per cent. The experiment serves to show the wide field for improvement existing in lighting conditions in coal mines and the benefits that might be secured by a moderate expenditure on research.

Meteorology at Southport.—Results of meteorological observations at Southport for the year 1921, and the annual report of the Fernley Observatory of the Corporation of Southport, compiled by the meteorologist, Mr. Joseph Baxendell, have recently been issued. The report is published in two editions, copies being circulated by the Southport Corporation, and by the Meteorological Office, Air Ministry. The Borough Observatory of Southport is the longest municipally-maintained meteorological station in the British Isles, observations having continued for the past 50 years. Daily, weekly, and monthly returns are supplied to the Meteorological Office. Much time has been devoted to the comparisons involved in the investigations of meteorological periodicities; among the clearly indicated cycles is one of 5 years, while a rainfall cycle of 53 years is said to be the chief. An appendix gives monthly averages, for 10 years, of the amount and duration of rainfall under different wind directions. It is shown that winds from southerly points are pre-eminently those of the rainy quarter. The most remarkable year during the half-century's existence of the observatory is stated to be 1921, although in the north-west of England it was not so dry as several previous years; the total deficiency of 4 inches of rainfall was trivial in comparison with the extraordinary drought over south-eastern England. For general fine-weather factors there is no known predecessor to equal it, the outstanding feature being the remarkably high mean atmospheric pressure. The underground water-level remained extremely low until the substantial winter rains in the latter part of December. Taken as a whole, the meteorological results will serve well as a guide for observations made by other municipal bodies.

Distance Thermometers.—Messrs. Negretti and Zambra have introduced a type of distance thermometer which appears to get over many of the difficulties and errors to which such instruments have been subject in the past. The new instruments depend on the expansion of mercury in a steel bulb to which a capillary tube of the required length is attached. This tube ends in a coiled Bourdon tube with the free end of which the pointer of the instrument gears directly. The pointer moves over a circular dial about 300° of which are occupied by the scale. The effect of change of temperature of the connecting capillary is eliminated by a wire of invar running down the tube and reducing the volume of mercury to such an extent that the change of its volume with change of temperature is identical with the change of volume of the steel tube. The errors of such an instrument tested at the National Physical Laboratory from 0° to 50° C. at no point of the scale exceeded 0·05° C.

Photo-elastic Research.—In a recent number of the Memoirs of the Society of French Civil Engineers (Bulletin de juillet-septembre 1922) Prof. E. G. Coker gives the text of a lecture, delivered by him last summer in Paris, which contains an up-to-date account of the method of exploring stresses in structures by means of celluloid models examined in polarised light, a method which is at present making rapid progress both here and on the Continent, and bids fair to become indispensable to every scientific engineer. Besides giving a sketch of the method and its general applications, Prof. Coker obtains new and interesting results concerning the testing of cement briquettes under tension, and compares the standard forms of such test-pieces adopted in Britain and France respectively. In particular, he shows that the standard briquettes adopted in both countries for cement tests lead to a strikingly unequal distribution of tensile stress across the middle section of the test-piece, and thereby to serious error in the deduced tensile strength. He suggests, as the result of photo-elastic research, a new shape of standard briquette which is free from this defect. Further illustrations of the method include a discussion of contact stresses and an investigation of the stresses arising from the action of cutting tools, both in the work and in the tool itself. This part of the lecture is partly a restatement of results previously described by the author and Dr. Chakko in the Proceedings of the Institution of Mechanical Engineers in April 1922, but various novel points are introduced.

The British Science Guild.

The Mansion House was an appropriate *venue* for the great meeting organised by the British Science Guild on February 27 to acknowledge and proclaim the importance of scientific method, scientific knowledge, and scientific research as factors in promoting "national and Imperial interests." In the Egyptian Hall, with its high curved roof, its brilliant stained-glass windows, its serried banners recalling battles and heroes of long ago, the Lord Mayor presided over a distinguished company of representatives of modern science and industry. The first citizen of London is the honoured custodian of many great traditions, among which not the least precious is the city's historic generosity in promoting education and science. The City and its Companies have in the past given freely of their wealth in aid of these great causes, and it is fitting therefore that their faith in science, so amply proved, should stimulate the new crusade for its increased national recognition. Not less significant was the King's message of encouragement which Lord Askwith read to the meeting, welcoming the efforts of the Guild "to stimulate the scientific spirit, and to secure that application of science to industries, commerce, and, indeed, in all fields of human activities, so essential to efficiency and to the closer fellowship of all parts of the Empire."

The Lord Mayor, in his introductory remarks, emphasised the usefulness of the Guild's work of propaganda. When, he said, the British Science Guild was founded in 1905, its first object was stated to be to convince British people, by means of publications and meetings, of "the necessity of applying the methods of science to all branches of human endeavour, and thus to further the progress and increase the welfare of the Empire." Modern civilisation is so closely bound up with the advance of scientific knowledge that all progressive citizens can realise the service which a body like the Guild is able to render to this country and to Imperial development. This is an age of science, when such wonders as X-rays, radium, and wireless telephony, which have added so greatly to human powers and communication, are accepted almost as commonplace parts of our daily life. More scientific work is being carried on now than ever before, and we may expect results which will be of even greater value than those already achieved. British science in several directions leads the world, and it is right that this fact should be more widely recognised. Science stands not only for new devices and powers, but also for accurate knowledge and the right use of man's capacity and individuality. Scientific method must, therefore, be applied to social problems if the true principles of progress are to be determined. The Guild stands for national service in a wide sense: it includes representatives not only of pure and applied science, but also of industry and capital. After the Napoleonic wars, the nation found itself exhausted and impoverished. Our national position was re-established through the steam-engine and the industrial development which followed. We have now to look to the science laboratory to restore our economic position, and even to improved agricultural production. Later in the meeting the same note was sounded by Sir Joseph Cook, High Commissioner for Australia, who pointed out that a vast amount of capital had been wasted through the war, but the loss would soon be made good if two blades of grass could be made to grow instead of one or if the speed of steamships and other forms of transport could be doubled.

The principal resolution was moved by Lord Askwith as president of the Guild and accepted unanimously in the following terms:

"That this meeting, convinced that the progressive use of scientific knowledge is essential to industry and commerce, and that the application of scientific method to all public affairs would ensure increased efficiency and economy, pledges itself to support the efforts of the British Science Guild to promote national and Imperial interests by means of these powerful factors."

A letter of apology for absence was read from Sir Joseph Thomson, which stressed the need for the popularisation of science on the widest possible basis. "It seems to me," Sir Joseph said, "that the remarkable increase in the opportunities for scientific research which has taken place in the last thirty or forty years has not been accompanied by a proportionate increase in the means of bringing matters of scientific interest before the great mass of the people. . . . I do not forget the work of some of the great newspapers in spreading an interest in science by the admirable articles they publish at frequent intervals, but the public I am thinking of does not read the *Times* or the *Morning Post*." A more urgent need was to arouse an interest in science in the bulk of the population, which would facilitate the passage of measures to promote the progress of science in this country. Lord Askwith endorsed this plea and urged also that a great deal more might be done to endow discovery. It was of immense importance, he considered, that men of science without the hope of immediate reward should probe the mysteries of Nature, and that new discoveries should be brought quickly into general knowledge.

The appeal for some further endowment of "problem-solvers"—the elder men of science who devoted their lives to research as apart from the young trained laboratory workers—was vigorously pressed by Sir Ronald Ross. It might be supposed that the discoverer of the cause of cancer or tuberculosis would soon become a millionaire, but he pointed out that Sir David Bruce, who solved the problem of sleeping sickness, was now in Madeira unemployed, and there were three or four others whom he could name. He suggested that the nation should pension scientific discoverers of pre-eminent worth, and allow them to go on working as they pleased.

The vote of thanks to the Lord Mayor and the other speakers was proposed by Lord Askwith and seconded by Lord Bledisloe, who made an interesting speech on the application of science to agriculture. It appears that Continental agriculturists use the results of the researches on fertilisers and plant diseases at Rothamsted more than we do ourselves.

The meeting was a prelude to the launching of a national appeal by the British Science Guild for increased personal and financial support, and an appeal committee has been appointed, of which Lord Askwith is president. The list of members includes many distinguished representatives of science and public life. The director of the appeal is Commander L. C. Bernacchi, physicist of Scott's first Antarctic Expedition. A comprehensive plan of objects and methods has been drawn up and will be widely circulated in due course. The details of the scheme were not announced to the meeting, but the Lord Mayor said at the conclusion of his speech that whatever support was given to it would be returned a hundredfold in national honour and profit.

Research in the Scheme of Higher Education.[1]

By Dr. Herbert H. Hodgson, The Technical College, Huddersfield.

The present time is exhibiting none other than a break in the continuity of civilisation. No longer must the production and recognition of supermen be left to chance, since unusual genius, in whatever quarter it may be found, must have a field provided for its activities if our place as a leading nation has to be maintained. It is the province of higher education to discover this genius, a province, which, owing to haphazard evolution, is largely at the mercy of the dilettante, and, as a consequence, not yet in a condition to evolve those power stations of mind without which the necessary creative atmosphere remains ungenerated. The practical results of the German system of higher education have been the creation and development of key industries wherever possible, these ensuring an industrial system which afforded the security of continuous employment of an extremely varied character. This conferred a measure of national stability which was stout enough to defy the whole world for four years, and, but for lack of psychological balance, might have retired the actual winner of an apparently drawn battle.

The industrial exploitation of chemical science by Germany has entirely changed the international situation, inasmuch as a flourishing all-round chemical industry is now essential to the continued success and progress of all great manufacturing activities. This industry dominates the whole trade situation, and no country, however friendly at present, must ever be in a position to dictate by means of it such terms as can spell eventually our decadence and commercial annihilation. An unemployment problem of so vast a magnitude as ours demands the exploration of every reasonable avenue which may provide economic work, a demand which leaves no room for the neglect of key industries to be used against us. This in itself is an answer to the query as to whether the material importance of the organic chemical industry warrants its foundation in Britain. Recent combinations in other countries between firms engaged in key industries are ominous portents for the future.

The greatest key industry is that of synthetic dyestuffs, which, once established permanently, will prove the greatest source of well-being to our nation yet conceived. Its potentialities are bewildering in their immensity and can create and fashion the very future itself, so it becomes imperative that no external nation must be allowed to possess such a weapon as a monopoly. The war demonstrated the temperamental fitness of our countrymen for the dyestuffs industry, and, in spite of the current hostile criticism, I hold with Sir William Pope that only a few years are required for the organisation of a perfect lattice of fine chemical industries.

No industry dependent upon men of science for its progress will be able to survive external competition of a kind which Germany, the United States, and Japan are capable of exerting, unless a creative atmosphere is generated within the walls of our schools and our standards of intellectual attainment are raised to a much higher level than at present obtains. It is not sufficiently realised how much research work has to be done before any tangible results accrue, and therefore a multiplication of agencies is necessary, a practical proposition only to be realised by means of our higher educational system.

Any comparison of pre-war British and German chemical ability which attempts to exalt the German as one apart, even as something chemically occult, must take the fact into account that so much of our best intellect as revealed by scholastic agency is absorbed into the civil service that the essence of Britain's research ability has never yet taken part in the industrial competition. In Germany the contrary has obtained. The British chemical mission to Germany after the Armistice found that industry there is systematically linked with the universities, and concluded that if our industries are to succeed in the future it is in this direction probably more than in any other that improvements must be effected.

It must be realised that higher education with respect to science and technology is at the parting of the ways, and whether the future is to emphasise the mediocre and the mechanical or to reveal latent genius will also decide whether the chemical industry, with its quota towards the solution of our unemployment problem, will also take root in this country. Our educational programme, therefore, must include a readjustment of the aims of technical education and the evolution of a new branch of the teaching profession to deal with the higher standard of student attainment necessary. No chemical department should be without a definite and distinct research section in which, at the earliest stage possible, students should be initiated into the methods of scientific inquiry. This was the practice of the great Hofmann, and it is as practicable to-day as it was in his brilliant period. The entire staff should also have service in the research section as part of their duties but with safeguards for individual expression. By this means a network of research colonies will be brought into existence, and the pivotal principle must be insisted upon that directors of research must not be prevented by details of organisation from actual personal participation. A large amount of individual responsibility will thus be generated with a greater resultant effort. As the late Prof. Meldola said, "I have not the least hesitation in declaring the belief that a school of chemistry which is not also a centre of research is bound to degenerate and to become a mere cramming establishment not worth the cost of maintenance." There should also be research centres on the lines of the Emperor William Institutes in Germany, an ideal proposed by Sir David Brewster seventy years ago for providing research careers for worthy men.

I would also suggest that patents should be examined by research organisations, and, where dishonest, the fact broadcasted, so that the intending fraudulent monopolist can be banished from our midst.

Another factor of far-reaching importance to industry is the establishment of English as a language for scientific publications at least co-equal with German. This can be secured on a stable basis only by the quality and quantity of our scientific output.

Only by the development of British research ability can our security as a nation be maintained and our prosperity advanced, since by it a lattice of industries will result, which, by reciprocity with the research agencies, will promote the extension of each. We shall then face the future with the determination to produce results in chemical science not inferior in quality or quantity to those in realms of knowledge where our leadership has never been in dispute.

[1] From a paper read at the Annual Meeting of the Association of Technical Institutions on March 3.

Physics in Industry at the Wembley Laboratories.

THE General Electric Company, Ltd., is now a very large organisation, which employs some twenty thousand workers. It has engineering works at Birmingham, where it manufactures all kinds of electrical machines. At Stoke, near Coventry, telephones are manufactured. At the Osram lamp works at Hammersmith, lamps and valves of all kinds are made. At Erith, the company took over a few years ago the works of Messrs. Fraser and Chalmers, which manufacture steam turbines and mining plant. At Southampton, electric cables of all kinds are manufactured, and the company has glass works at Lemington-on-Tyne. Mainly on the initiative of Mr. Hugo Hirst, the managing director, it was decided some six years ago to establish a central laboratory to carry out the scientific and industrial researches which are essential for the progress of industry. Mr. Clifford Paterson, who was then the head of the electrotechnical department of the National Physical Laboratory, was appointed superintendent, and he is now helped by a staff of physicists and engineers many of whom have world-wide reputations.

The opening of the research laboratories on February 27 was a very interesting function. Lord Robert Cecil, speaking at the opening ceremony, said that the immediate task of the country is to repair the waste of the war. To do this the first and most essential requirement is to use every endeavour to increase the output of human energy and skill. This can only be done in two ways, namely, by reducing expenditure and by increasing the efficiency of production. Research, by making every man's skill go further, adds to the world's wealth. Science has no territorial boundaries. By promoting research the relations between this country and the world are improved. Sir J. J. Thomson, who also spoke, pointed out that it is absolutely necessary that a research laboratory should have a highly efficient staff. The capacity for the highest kind of research is rare. Training may increase the efficiency of a researcher, but it cannot put insight and originality into him. It is also certain that no research laboratory can guarantee delivery. The output of such a laboratory is always highly irregular and spasmodic. Sir Joseph Thomson also dwelt on the importance of cultivating the thinking powers of the community to the utmost.

The research laboratories are situated near Wembley and have a total floor area of 80,000 square feet, but they have ample room for expansion. The building has a north-light roof and nearly all of it is only one storey in height. The upper floor galleries carry most of the electric cables and the hydraulic pressure, steam, gas, and vacuum pipes required by the experimenters.

These galleries carry the arterial system essential for the laboratory without the necessity for conduits or ducts. This greatly increases the flexibility of the whole system.

The machinery in the central sub-station supplies the electric power, keeps the gases in circulation, and maintains the vacuum in the vacuum pipes throughout the building. Power at a pressure of 2850 volts and on the three-phase system is supplied by the North Metropolitan Electric Supply Co., and is converted into various pressures, both direct and alternating, for the distributing mains by means of motor generators and transformers. The lighting system is permanent, and is not touched for experimental purposes. The method of arranging the experimental distributing system is an extension of that which Mr. Paterson used at the National Physical Laboratory.

In addition to the electric machinery the substation contains the vacuum and compressor plant. Two rotary compressors feed into a horizontal boiler placed in the gallery, and this stores the compressed air which is required for experimental purposes. There are also three vacuum pumps driven by motors which are in continuous operation. These exhaust a fine vacuum main to the low pressure of 0·5 mm. of mercury and rough vacuum mains to pressures down to 6 mm. of mercury. There are also high-pressure hydraulic mains, compressed-air mains, and a one-inch hydrogen main.

There are two splendidly equipped workshops, one for metal and one for wood. These make the special apparatus required by the staff. They also engage in research work of their own, devising and improving automatic machinery and suggesting means of accelerating and improving the methods of production.

In the vacuum physics laboratory, X-ray analysis and analyses for detecting traces of gases are made. A novel question that is being investigated is the X-ray danger that may exist in connexion with the use of valve tubes at high voltages. For example, when these tubes are being exhausted, pressures of 10,000 volts and upwards are sometimes applied. Ordinary bulb glass which contains about 18 per cent. of lead is impermeable to these rays, but the special silica tubes often used in valve work are permeable; it is therefore necessary to know whether the work is dangerous or not. The problems produced by the static charges and other high voltage effects produced in bulbs are also being studied.

Some of the laboratories, for example the one for measuring the life of lamps, are used for routine testing. There were 800 lamps undergoing life tests simultaneously. They were of all kinds, carbon filament, metal filament, neon lamps, etc. Some of the neon lamps produce very novel effects and they are in great demand at present in physical laboratories. In photometry the equipment is very complete, and the various problems of illumination are being investigated by most scientific methods. A novel photometer was shown in operation which measured the absorbing power of various surfaces for light. By the use of this instrument the "blackness" of the inside coatings of lamp bulbs tarnished by use can be measured.

A specially novel and interesting feature of the laboratories is that they contain four small experimental factories for making electric lamps, tungsten wire, thermionic valves, and primary batteries, and these laboratory factories are regarded as tools which any of the research staff can use in connexion with the further development of a research. It is inadvisable to specialise research to too great an extent. Lamp research, for example, is not confined to the intensely interesting work on vacuum physics. It is equally concerned with metallurgical research, glass research, radiation from solids and gases, and high tension electrical phenomena in general. In a research laboratory it is necessary that the staff should be interested in practically every kind of research.

Many other interesting researches are being carried out at Wembley, and some of the work done has already proved of great commercial value in the factory. The importance of physics in electrical development may be illustrated by the case of the ordinary switch for the electric lamp. In the old days, an ominous bluish light sometimes made its appearance when the switch was turned off, and occasionally a switch was burnt out. The base of the switch was sometimes made of wood, which is a very poor insulator. Electricians then improved matters by accelerating the rate at which the terminal pieces separated when the current was broken. Later on it was found that a double air break was a vast improvement, and the base is now made of the best vitreous porcelain, which is practically a non-conductor. Those who use switches nowadays seldom if ever consider the thought that has been expended on their development. Every device in a progressive factory is undergoing continual improvement, and practical men recognise the value of an experimental and theoretical study of the physical laws which govern its development.

The new laboratory at Wembley is one of the largest research laboratories in this country. Compared with American standards, however, it is not large. The research laboratory of the Western Electric Co., Inc., of 463 West Street, New York, has a 13-storey building on a floor area of 400,000 square feet, and employs 1600 full-time researchers under the able guidance of Dr. Jewett, president of the American Institution of Electrical Engineers. The results obtained, however, are seldom in proportion to the size of a research laboratory, and we were much impressed by the ability of the staff at Wembley.

University and Educational Intelligence.

Aberdeen.—The honorary degree of LL.D. was conferred, *in absentia*, on the Duke of Richmond and Gordon, Chancellor of the University, at a meeting of the Senatus Academicus held on Tuesday, February 27.

Prof. W. Mitchell, vice-chancellor and Hughes professor of philosophy in the University of Adelaide, South Australia, has been appointed Gifford lecturer for the sessions 1924–25 and 1925–26.

Cambridge.—The Grace approving the regulations for the admission of women students of Girton and Newnham Colleges to titular degrees in the University has now been approved and one stage of a long-drawn-out controversy has been completed. Among the other privileges granted to women students by the new regulations is included the right to be admitted to instruction in the University and to University laboratories and museums, though the number receiving such instruction at any one time is limited to five hundred. Women are now admitted as research students on the same footing as present candidates for the degrees of M.Litt., M.Sc. and Ph.D.

The Right Hon. T. Clifford Allbutt, Gonville and Caius College, Regius professor of physic, has been appointed as delegate to the celebration next June of the 800th anniversary of the foundation of St. Bartholomew's Hospital and the Priory Church of St. Bartholomew the Great.

The opening of the new chemistry section of the Technical High School of Stockholm is announced in the *Chemiker Zeitung* of February 10. The building cost 3,300,000 kroner, and has four large laboratories for inorganic, organic, technical, and electrochemistry, and a smaller for the study of fermentation. The Director is Prof. W. Palmaer. It is stated that in size the building is exceeded only by that of Boston.

A report on the development of adult education in rural areas has been issued (H.M. Stationery Office, 6*d*.) by the Adult Education Committee constituted in April 1921 by the Board of Education. The report reviews the work in this field of existing organisations—Local Education and other County Authorities, Women's Institutes, University Extension Committees, Workers' Educational Association, Association of Village Clubs, Y.M.C.A., Educational Settlements, and County Unions of village organisations,—the conditions of State aid, and the available sources of supply of books, and concludes with several practical suggestions. Among the opinions formulated by the Committee are: schemes of rural education properly organised can secure immediate and notable success provided village initiative and co-operation are encouraged; some form of county organisation, such as the Oxford Rural Community Council, is essential; national organisation is desirable and has been provided for by the recent establishment of a representative council by the National Council of Social Service; pioneer lectures and short courses of lectures are a necessary prelude to formal classes and merit State aid; the full development of the Carnegie Trust Rural Library Scheme will solve most difficulties as to the supply of books. As regards this last point, it is explained in a highly interesting memorandum appended to the report that it is the policy of the trustees to promote the establishment of county schemes controlled by County Council Education Committees, and 192,000*l*. was set aside by the trustees in February 1920 to enable every county to inaugurate one. By January 1922 thirty-eight were in operation. The key-stone of the whole system is the Central Library for Students (London and Dunfermline), from which any good-class modern book on a serious subject can be obtained through the county librarians.

Statistics of 670 Universities, Colleges, and Professional Schools, published by the United States Bureau of Education as Bulletin, 1922, No. 28, shows a total student enrolment for 1919–20 of 521,754, of whom rather more than one-third were women; by departments—preparatory 59,309, collegiate 341,082, graduate 15,612, professional 57,131. Of the 670 institutions, 109 were under public and 561 under private control: 82 were independent professional schools. Of 586 universities and colleges with undergraduate students, 354 were co-educational, and reported 162,558 men and 96,908 women; 117 were maintained exclusively for men and 115 exclusively for women. Enrolments in the professional schools were: law 20,992, medicine 14,242, dentistry 8809, theology 7216, pharmacy 5026, veterinary medicine 908. The percentage of women students ranged between 14 in pharmacy and 0·01 in veterinary medicine. Engineering schools enrolled 51,908 students, almost all men, distributed as follows: general engineering 10,231, civil 8859, mechanical 11,789, electrical 9469, mining 3048, chemical 5743. The number of engineering students more than doubled itself in the decade 1910–20. The total amount of benefactions—excluding government grants—was 65 million dollars. The total income per student—363 dollars in 1920—has risen steadily since 1890, when it was only 68 dollars. During the same period the percentage of receipts derived from the Federal Government, the State, and the city has increased from 12 to 27 and of student fees from 22 to 26, while the percentage from productive funds and private benefactions has decreased from 65 to 38. The following figures relate to universities and university colleges (excluding Oxford and Cambridge) in Great Britain in receipt of annual Treasury grants in 1920–21: income per student 54*l*., percentage of income from endowments 11, parliamentary grants 34, grants from local authorities 9, tuition fees 32.

Societies and Academies.

London.

Royal Society, March 1.—A. **Mallock**: The effect of temperature on some of the properties of steel. The period of torsional vibration and the length of a steel wire were automatically and continuously recorded in terms of time, while the temperature was varied between 15° and 1000° C. The results show (1) that the variation of the rigidity of steel between ordinary temperature and a dull red heat is small (less than 1 per cent.); (2) that above the critical temperature (about 800° C.) the rigidity decreases rapidly; (3) that the temperature coefficient of expansion does not show any marked change as the metal passes through the critical temperature; but (4) that a comparison with the cooling curves of iron and steel proves that the specific heat of the high temperature form of the metal is much less than it is at temperatures below the critical point.—C. H. **Lees**: Inductively coupled low-resistance circuits. The oscillations in each of two circuits of low resistance coupled by their mutual inductance can be simply expressed in terms of a certain product of capacitance and inductance. The expressions for the currents lead to a simple graphical solution of the problem.—Lord **Rayleigh**: Studies of iridescent colour, and the structure producing it.—(1) The colours of potassium chlorate crystals. The structure of the iridescent potassium chlorate crystals investigated by Stokes and the late Lord Rayleigh is examined microscopically. The periodic twinned structure inferred by the latter is clearly shown in the photographs taken under the microscope with polarised light. Some crystals have exceedingly complex structure, showing many groups of evenly spaced twin planes and a very complex reflection spectrum. This results from high interference from twinned layers situated a considerable distance apart. Chlorate crystals, giving a silvery reflection, were obtained by Madan, who heated the ordinary colourless crystals to about 250° C. A complex twinned structure is induced, and photographs of the structure of the crystal and of the reflection spectrum show corresponding irregularities in each, resulting from want of flatness in the twin planes. (2) Mother-of-pearl. The results generally confirm those of Brewster and A. H. Pfund. Micro-photographs show the grating structure of a pearl oyster shell and the structure of parallel layers of an "ear" shell. The absorption spectrum of the latter shows that in agreement with the spacing of the layers the reflection is of the second order. (3) The colours of Labrador felspar. The colours seen by reflection arise from two distinct origins:—(*a*) Specular reflection from tabular inclusions, which show the colours of thin plates and are often 0·2 mm. in dimensions; they are distributed parallel to one of the cleavages. (*b*) Diffuse reflection from a plane about 15° away from the cleavage mentioned; this is the source of the striking colours observed. When the diffuse reflecting plane is examined microscopically under conditions which ensure that the light only comes from a very thin stratum, it is found that the plane of reflection is patchy. The patches are of irregular outline. The diffuse character of the reflection is accounted for by the small diameter of these reflecting surfaces, regarded as independent optical apertures. Their size (0·005 mm.) accounts approximately for the angular diameter of the diffuse image of a point source seen by reflection. The colour of the reflection is not sharply limited to special regions of the spectrum, and can be explained by the interference of streams of light from the two surfaces of each patch. The patches may be fissures in the material, and there is evidence that their thickness is not absolutely uniform. The brightness of the colour is explicable by the large number of reflecting patches adding their effects, without definite phase relation such as would give rise to regular interference.—L. V. **King**: On the complex anisotropic molecule in relation to the dispersion and scattering of light.

Society of Public Analysts, February 7.—Mr. P. A. Ellis Richards, president, in the chair.—E. **Griffiths-Jones**: Titanium in Nile silt. Titanium is determined by a colorimetric method after freeing the sample from silica; 1·3-2·55 per cent. of titanium oxide was found. Egyptian straw showed only 0·4 per cent. of titanium oxide on the ash.—Osman **Jones**: Notes on the examination of preserved meats, etc. The presence of a trace of zinc chloride in the tin container (which sometimes arises through the use of this salt as a soldering flux) causes a more rapid absorption of tin by the food contents; the use of sealing fluid containing a high boiling-point solvent also causes a disagreeable flavour to be imparted to the food material. The absorption of tin by the meat contents of a can is greatest at the time of processing and almost ceases after about 4 months. A dilute solution of iodine in potassium iodide gives a crimson colour with agar, while with gelatin an orange-coloured precipitate is produced.

Optical Society, February 8.—F. W. **Preston**: On the properties of pitch used in working optical glass. Pitch as a material for mounting lenses for polishing possesses many remarkable advantages. Its colour is valuable; the dull black surface in contact with the lens prevents reflection of light at the second face of the glass. Its coefficient of expansion approximates to that of glass, it melts at a relatively low temperature, and remains plastic through a considerable range. Pitch, being an undercooled liquid, may be made sufficiently solid to resist deformation by external pressures during the polishing operation, and yet left sufficiently plastic to yield to internal stresses, so as to be self-annealing at ordinary temperatures. The alteration of properties on prolonged heating is its most serious disadvantage.—T. Y. **Baker**: Prismatic astrolabe designed and made at the Admiralty Research Laboratory, Teddington. This instrument, used for accurate geodetic survey work, is a modification of that designed by MM. Claude and Driencourt, which has been extensively used in Egypt. The modifications are: (i.) The prism can be rotated about an axis parallel to its edges, and the angles of the prism are allowed to depart slightly from 60°; by using each edge of the prism in turn as the front edge, three observations of the star can be made instead of only one, the mean of the measured altitudes being exactly 60°. (ii.) A refracting prism of small angle is mounted to cover one quadrant of the object glass and a duplicate image of one star is thus produced in the field of view. The duplicated images are on the same horizontal level. Observation for contact is made by noting the instant when the descending image is on a level with and between the duplicated images. Laboratory trials show that whereas the mean error of observation with the old scheme was 0·2″, with the new arrangement it is 0·12″.

Aristotelian Society, February 19.—Prof. Wildon Carr in the chair.—C. E. M. **Joad**: The problem of free will in the light of recent developments in philosophy. It is generally admitted that on the basis of the Materialist and Mechanist theories, the conditions which must be satisfied if free will is possible are not fulfilled, since causation is conceived as proceeding always from the material to the mental. It is not generally recognised, however, that the Vitalist theories, for which the ultimate reality is life or spirit, also preclude the possibility of free will. There are two difficulties in regard to the theory of a vital principle or spirit. (1) How can a homogeneous unity differentiate itself into individual manifestations which are in some sense less real than itself, unless it contains in itself the principle of difference *ab initio*, that is to say, unless it is a plurality and not a unity? (2) Assuming that this difficulty could be surmounted, how can the individuals so formed act, desire, or will with a motive force, other than that derived from the underlying vital principle? If the energy with which they desire is that of the vital principle, and the will with which they suppress the desire, if they do suppress it, is also that of the vital principle, it follows that they are responsible neither for their desires nor for their suppression. These difficulties cannot be solved on the basis of a reality which consists of an initial unity, but the problem of free will, if not actually soluble, takes an entirely different complexion if an initial dualism or pluralism be assumed.

Association of Economic Biologists, February 23.—Prof. E. B. Poulton, president, in the chair.—Sir John **Russell**: Partial sterilisation of soil. The discovery that partial sterilisation increased the bacterial activity of soil was accidental, but when followed up it showed protozoa were present in the soil depressing bacterial numbers. It also showed that certain soil bacteria have the remarkable power of breaking the benzene ring, decomposing such unlikely substances as benzene, toluene, naphthalene, phenol, etc., and utilising them as food. Partial sterilisation kills or reduces disease organisms: here, however, heat is the only certain agent, the various chemical substances having specific properties rendering their general use difficult. A knowledge, however, of disease organisms to be suppressed and of the substances toxic to those organisms, allow the costly heating process to be superseded by the much cheaper chemical treatment. Finally, partial sterilisation produces chemical changes in the soil, some of the products of which have important effects on the plant. Thus, heating soil produces something which stimulates root development. At present partial sterilisation is used by the scientific worker to open up new fields of investigation, and by the practical grower to obtain better crops as the result of the increased bacterial activity, the freedom from disease organisms, and the presence of the root-stimulating substances.—H. G. **Thornton**: The destruction of aromatic antiseptics by soil bacteria. Soil antiseptics fall into two groups: those resembling toluene in mode of action, and those resembling phenol. The second group produces a sudden and great increase in the bacterial numbers in the soil, which is only temporary and is not accompanied by any considerable increase in ammonia production. The effect suggested that organisms fed on this group of compounds. Phenol, cresol, and naphthalene, when added to ordinary manured soil, disappear rapidly, due largely to a biological cause, and bacteria were found which in pure culture were able to derive the energy necessary for growth by decomposing these compounds. These organisms fell into three groups, non-motile resembling *B. phloei*, large rods producing clostridial sporangia, and short oval pseudomonads. The Pseudomonas group is of chief importance in producing phenol destruction in the soil.

Paris.

Academy of Sciences, February 12.—M. Albin Haller in the chair.—C. **Guichard**: Two triple orthogonal systems which correspond in such a manner that the second tangent of one shall be the polar reciprocal of the third tangent of the other with respect to a linear complex.—A. **Andant**: The application of photography to the study of critical opalescence. The phenomenon was studied by means of a Hilger spectrograph, and the opacity measurements were made with a Fabry and Buisson microphotometer. Curves are given showing the variation of opalescence in ethyl acetate with temperature and with the wave-length.—M. **de Broglie** and J. **Cabrera**: The K absorption spectrum of element 72 (celtium). Some specimens containing zirconium show a feeble band with wave-length $\lambda = 0{\cdot}1905$Å. From corresponding spectra of ytterbium ($N = 70$) and lutecium ($N = 71$) this line would belong to the element of atomic number 72.—Mlle. Irène **Curie**: The distribution of length of the α-rays.—L. J. **Simon**: Viscosity, neutralisation, and isomorphism. The gradual neutralisation of arsenic and phosphoric acids has been followed by viscosity measurements. NaH_2PO_4 is indicated by a well-marked viscosity minimum: Na_3PO_4 shows a viscosity maximum. The arsenate and phosphate viscosity curves are very similar.—H. **Colin** and Mlle. A. **Chaudun**: The diastatic hydrolysis of the glucosides of alcohols. Determination of the molecular weights. An experimental method of fixing the molecular weight of a glucoside by measuring the quantity of enzyme for which the glucose set free from a fixed weight of glucoside no longer increases with the amount of the enzyme. Measurements of propyl, isopropyl, butyl, and isobutyl glucosides are given.—P. **Job**: The complex ions formed by silver salts and aqueous solutions of ethylenediamine.—Marcel **Delépine**: The potassium irido-dipyridino-dioxalates.—Marcel **Godchot**: The 1 : 2 cyclohexanediols and ortho-chloro-cyclohexanol.—Paul **Pascal** and M. **Garnier**: Two definite combinations of nitrogen peroxide and camphor. The melting-point curve of camphor-nitrogen peroxide indicates two definite compounds, $5N_2O_4 + 4C_{10}H_{16}O$ and $2N_2O_4 + 3C_{10}H_{16}O$.—Charles **Baron** and Albert **Verley**: Contribution to the study of a national petrol. Study of the miscibility of alcohol (94-100 per cent.) with ordinary petrol.—F. **Diénert**: Contribution to the study of the circulation of water in the chalk. Results of experiments with fluorescin. Water circulation in the chalk takes place by fissures only and not by filtration. A detailed experimental study of each region is necessary to determine the course of the water underground.—Pierre **Bonnet**: The existences of limestones containing Ural Fusulina in southern Transcaucasia.—Raoul **Blanchard**: The terraces of glacial closing.—Sabba **Stefanescu**: The contraction of the lower maxillary of mastodons and elephants.—Emile F. **Terroine**, A. **Feuerbach**, and E. **Brenckmann**: The unit of energy metabolism and the active mass of organisms.—Albert **Lécaillon**: The tendency to albinism in the hybrids of *Dafila acuta* and *Anas boschas*.—Jules **Amar**: The law of minimum in biology.

Official Publications Received.

Carnegie Institution of Washington. Year Book No. 21, 1922. Pp. xxii+414. (Washington.)

Annual Report of the Director, United States Coast and Geodetic Survey, to the Secretary of Commerce for the Fiscal Year ended June 30, 1922. Pp. iv+148+38 charts. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Forty-third Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior for the Fiscal Year ended June 30, 1922. Pp. ii+80. (Washington: Government Printing Office.)

Proceedings of the University of Durham Philosophical Society. Vol. 6, Part 4, 1922-1923. (John Theodore Merz Memorial Number.) Pp. 215-290. (Newcastle-on-Tyne.) 2s. 6d.

Carnegie Institution of Washington. Annual Report of the Director of the Department of Botanical Research. (Extracted from Year Book No. 21 for the Year 1922.) Pp 47-76. (Washington.)

Report of the Director of the Observatory to the Marine Committee, and Meteorological Results deduced from the Observations taken at the Liverpool Observatory, Bidston, Birkenhead, in the Years 1920-21. (Published by order of the Mersey Docks and Harbour Board.) Pp. 75. (Bidston.)

Diary of Societies.

SATURDAY, MARCH 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (4).

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Conversazione.

MONDAY, MARCH 12.

VICTORIA INSTITUTE (at 1 Central Buildings, Westminster), at 4.30.—Rev. Prof. A. S. Geden: Value and Purpose of the Study of Comparative Religion.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Col. J. F. C. Fuller: Problems of Future Warfare; to be followed by a discussion on The Medical Problems of Future Warfare.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Man's Posture: its Evolution and Disorders (4) (Hunterian Lectures).

ROYAL SOCIETY OF ARTS, at 8.—J. E. Sears, jun.: Accurate Length Measurement (2) (Cantor Lectures).

SURVEYORS' INSTITUTION, at 8.—C. G. Eve: The Re-valuation for Landlord's Property Tax, Schedule A.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—O. G. S. Crawford: Air Survey and British Archæology.

TUESDAY, MARCH 13.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. C. G. Seligman: Rainmakers and Divine Kings of the Nile Valley (1).

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Prof. F. R. Fraser, Dr. A. N. Drury, Dr. A. E. Clark-Kennedy, and Dr. T. F. Cotton: Discussion on the Action of Quinidine in Cases of Cardiac Disease.

ROYAL SOCIETY OF MEDICINE (General Meeting), at 5.—J. E. Adams: The Urgent Need for Education in the Control of Cancer, to be followed by a discussion by Dr. C. P. Childe, Lord Dawson, Dr. H. Spencer, and others.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. G. Evans: The Nature of Arterio-sclerosis (3) (Goulstonian Lectures).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (Annual General Meeting) (at Royal Society of Arts), at 5.30.—Prof. J. S. S. Brame: Presidental Address.

MINERALOGICAL SOCIETY (at Geological Society of London), at 5.30.—A. Hutchinson: A Graphical Method of correcing Specific Gravity Determinations.—C. E. Tilley: Genesis of Rhombic Pyroxene in Thermal Metamorphism. Mineral Associations and the Phase Rule.—C. S. Garnett: A Peculiar Chlorite-rock from Ible, Derbyshire. The Dissociation of Dolomite.—A. Brammall and H. F. Harwood: The Dartmoor Granite: (a) Porphyritic Felspars, and Biotite; (b) Andalusite, Sillimanite, Cordierite, and Spinellids.—J. G. C. Leech: Some Occurrences of Titanium Minerals on St. Austell Moor.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—H. Gordon: The Effect of Schooling on Intelligence Tests.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—W. A. Dexter: The Development of the Air Pump for High Vacuum.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Annual General Meeting.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—C. H. Caffyn: Rocks under the Microscope.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Miss M. Edith Durham: "Bird-men" and related Customs in the Balkans.

SOCIOLOGICAL SOCIETY (at Leplay House, 65 Belgrave Road), at 8.15.—J. A. Hobson: Bias in the Social Sciences.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. C. S. Myers: The Association of Psychoneuroses with Mental Deficiency.—Dr. H. J. Norman: Genius and Insanity.

WEDNESDAY, MARCH 14.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Man's Posture: its Evolution and Disorders (5) (Hunterian Lectures).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.

FELLOWSHIP OF MEDICINE (at Royal Society of Medicine), at 5.30.—A. J. Walton: The Differential Diagnosis of Surgical Dyspepsias.

INSTITUTION OF AUTOMOBILE ENGINEERS, at 7.45.—Major T. G. Tulloch: Multiple-wheel and Track Motor Vehicles.

ROYAL SOCIETY OF ARTS, at 8.—Sir William Warrender Mackenzie: Industrial Arbitration.

THURSDAY, MARCH 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lt.-Col. E. A. Strange: Japanese and Chinese Lacquer (1).

ROYAL SOCIETY, at 4.30.—G. C. Steward: Aberration Diffraction Effects.—Lord Rayleigh: Further Observations on the Spectrum of the Night Sky.—Lord Rayleigh: Studies of Iridescent Colour, and the Structure producing it. IV. Iridescent Beetles.—Prof. J. W. Nicholson: Oblate Spheroidal Harmonics and their Applications.—Prof. J. W. Nicholson and Prof. F. J. Cheshire: The Theory and Testing of Right-angled Prisms.—Prof. J. C. McLennan and D. S. Ainslie: The Fluorescence and Channelled Absorption Spectra of Cæsium and other Alkali Elements.—Dr. W. Stiles: The Indicator Method for the Determination of Coefficients of Diffusion in Gels, with special reference to the Diffusion of Chlorides.—H. T. Flint: A Generalised Vector Analysis of Four Dimensions.

LINNEAN SOCIETY OF LONDON, at 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. J. Hall: Encephalitis Lethargica (Epidemic Encephalitis) (1) (Lumleian Lectures).

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Prof. B. Melvill Jones: The Control of Aeroplanes at Slow Speeds.

INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30—Annual Meeting.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Sir Richard Gregory: The Position and Character of Science in Schools.

INSTITUTION OF ELECTRICAL ENGINEERS AND ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 6.—F. Hooper and J. W. Beauchamp: Co-operation between the Architect and the Electrical Engineer.

CHEMICAL SOCIETY, at 8.—E. H. Usherwood and M. A. Whiteley: The Oxime of Mesoxamide (*Isonitrosomalonamide*) and some Allied Compounds. Part III. Ring Formation in the Tetra-substituted Series.—H. H. Morgan: The Preparation and Stability of Cuprous Nitrate and other Cuprous Salts in the presence of Nitriles.—F. Challenger, A. L. Smith, and F. J. Paton: The Interaction of Hydrogen Sulphide, Thiocyanogen, and Thiocyanic Acid with Unsaturated Compounds.—Prof. T. M. Lowry: The Polarity of Double Bonds.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers, Inc.), at 8.—W. B. Clarke and others: Discussion on The Heat Treatment of Non-Ferrous Metals.

CAMERA CLUB, at 8.15.—C. P. Crowther: The Man Behind the Camera.

FRIDAY, MARCH 16.

ROYAL SOCIETY OF ARTS (Dominions and Colonies and Indian Sections), at 4.30.—Lt.-Col. Sir Leonard Rogers: Recent Advances towards the Solution of the Leprosy Problem.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Dr. F. M. R. Walshe: The Symptomatology of Eighth Nerve Tumours.—W. Trotter: The Surgical Treatment of Tumours of the Eighth Nerve.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Man's Posture: its Evolution and Disorders (6) (Hunterian Lectures).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Second Report of the Steam-Nozzles Research Committee.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 6.30.—L. F. Fogarty: Accumulators, Dry Cells, and the Currents used in the Reception of Radio Telephony, illustrated by Experiments.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—C. H. Woodfield: Comparative Power Costs.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group Meeting, in conjunction with the Affiliation of Photographic Societies), at 8.—R. H. Lawton: A Criticism of the Prints in the Affiliation Print Competition.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Prof. Gosta Forsell: Some Observations on Movements of Gastro-intestinal Mucosa.

SATURDAY, MARCH 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (5).

PUBLIC LECTURES.

SATURDAY, MARCH 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Great Sea-serpent.

MONDAY, MARCH 12.

INNER TEMPLE HALL, at 8.—Dr. C. Porter: The Principles and Practice of Sanitary Legislation (Chadwick Lecture).

TUESDAY, MARCH 13.

LONDON SCHOOL OF ECONOMICS, at 5.—Sir Henry Reid: Food Supplies (Statistics, before, during, and after the War) (4).

UNIVERSITY COLLEGE, at 5.15.—Prof. E. T. Whittaker: Electric Fields in Atomic Physics (succeeding Lectures on March 15, 20, and 22).

WEDNESDAY, MARCH 14.

KING'S COLLEGE, at 5.30.—Sir Richard Gregory: The Influence of Science.

THURSDAY, MARCH 15.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 5.—H. S. Goodhart-Rendel: Architecture—a Necessity or a Luxury?

CENTRAL LIBRARY (Fulham Road), at 8.—A. H. Page: Architectural and Record Photography.

FRIDAY, MARCH 16.

UNIVERSITY COLLEGE, at 5.30.—Sir Gregory Foster: Lectures—their Use and Abuse.

CHELSEA POLYTECHNIC, at 8.15.—Prof. A. C. Seward: A Summer in Greenland.

SATURDAY, MARCH 17.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. A. Abram: Travelling in the Middle Ages.

NATURE

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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A National Water Policy.

THE Minister of Health has recently appointed a Standing Advisory Committee "to confer with representatives of the Ministry on questions of water supply." From a reference in the public announcement of this appointment to the final report of the Water Power Resources Committee of the Board of Trade, it would appear at first sight that the step is the outcome of one of the recommendations put forward by that Committee in its report of November 1921, which was reviewed in NATURE of February 9 last year (vol. 109, p. 161). The proposal therein made, it may be recalled, was for the formation by Act of Parliament of a controlling water commission having jurisdiction over England and Wales, with statutory powers and duties. In commenting on such a far-reaching and momentous proposal, we felt it desirable to deprecate the idea of setting up a fresh department with a retinue of officials and an additional burden of salaries for the taxpayer.

Our first impression, therefore, was one of gratification that apparently the departmental proposition had been dropped and that, in place of it, there was to be a "Standing Committee," presumably honorary, with advisory functions. On further consideration, however, we became less confident that the announcement covered all that it implied, and whether, in fact, it was in any degree a materialisation of the Water Power Committee's findings. Inquiry has confirmed the suspicion that the Ministry of Health is only concerned with the water question as regards supplies for domestic use, and that the terms of reference of the Advisory Committee, though unspecified, cannot possibly be stretched to cover functions which lie within the province of the Board of Trade.

An inspection of the list of the committee shows it to comprise the names of six gentlemen connected with municipal waterworks administration in various official capacities. With one exception, we miss altogether any name which appeared as signatory to the very full and comprehensive report of the Water Power Resources Committee. There is, indeed, a marked absence of that representation of broadly national, scientific, and industrial interests which should, in our opinion, form a prominent, if not a predominant, element in a committee dealing with the policy of development of the water resources of the country.

This is the more disappointing in that, according to the Press, the first meeting of the committee has already been held, and it is announced that it discussed two matters which were in the forefront of the Water Power Resources Committee's recommendations, and have been the subject of earnest advocacy by NATURE for a number of years past. These are (1) the formulation of the outlines of a national water policy, and (2) the survey of the water resources of England and Wales. We are not in possession of information as to the views of the members of the Advisory Committee on these points, but we conceive that they must have been somewhat seriously handicapped by the absence of assistance from the compilers of the very valuable report to which we have alluded. In regard to the second point, we note that the survey is already in hand, and is being made by the Engineering Department of the Ministry of Health. We confess that we are puzzled by this statement. Conservation and control of water power resources for industrial purposes is not very obviously a question of health, or of physical well-being. We are therefore at a loss for an explanation, unless it be, that the survey is limited to sources of water supply for domestic use. If so, this is not only regrettable as making it an inquiry of inadequate scope, but it is also inconsistent with the announcement that the survey is being prosecuted "on lines recommended by the Water Power Resources Committee in their final report." Turning to that report, we find the recommendation expressed as follows:

"That in view of the importance in the national interest of the utilisation of water power, wherever this is commercially practicable, the Board of Trade, or the Electricity Commissioners, should be charged with the duty of studying, supervising, and promoting the development of all water power. The (Water Power) Department should collect data concerning, and cause surveys to be made of water power resources, and they should give the widest publicity to the results of their inquiries."

Clearly it is not within the province of a Ministry of Health to prosecute such a research, which must lie outside the education and training of its officials. Our own suggestion was that the work might be done as a branch of the Ordnance Survey, as it is done in the United States by the Geological Survey.

A matter of such outstanding importance as national water power control demands the most careful and competent handling. It has been the subject of a searching and painstaking investigation by a committee thoroughly representative in character, the recommendations of which, after several years of exhaustive study and the issue of three reports, were to the effect that the matter did not admit of procrastination or delay, and that it should be dealt with on a generous and effective scale. They were "thoroughly convinced of the necessity of such action if the national water resources are to be properly conserved and fully and systematically utilised for all purposes, and that the work should be proceeded with unremittingly." We therefore urge that the matter should be entrusted to a committee with a scientific and technological element of adequate proportions, and that the survey should be placed in the hands of a department closely associated with this particular class of work.

The Gas Industry.

(1) *The Administration and Finance of Gas Undertakings: with Special Reference to the Gas Regulation Act*, 1920. By G. Evetts. Pp. xi + 374. (London: Benn Bros., Ltd., 1922.) 32*s*. 6*d*. net.

(2) *Modern Gasworks Chemistry*. By Dr. G. Weyman. Pp. x + 184. (London: Benn Bros., Ltd., 1922.) 25*s*. net.

(3) *Gasworks Recorders: their Construction and Use*. By Dr. L. A. Levy. Pp. xi + 246. (London: Benn Bros., Ltd., 1922.) 35*s*. net.

(4) *The Distribution of Gas*. By W. Hole. Fourth edition, rewritten and enlarged. Pp. xv + 699. (London: Benn Bros., Ltd., 1921.) 50*s*. net.

THE gas industry had its modest origin in the researches of William Murdoch, the "incomparable mechanic" to whom the Royal Society awarded its Rumford medal for his work in the production and utilisation of illuminating gas. Its rapid growth owes much to the co-operation of the scientific workers, although in the early days, even as now, there were not lacking prominent and distinguished men of science prepared to wail a Jeremiad over the industry. While to-day the nature and magnitude of its operations entitle the gas industry at least to contend for pride of place among applied sciences, whether chemical, mechanical, or physical, it cannot be too strongly emphasised that the industry is the child of pure science, and its present-day problems the problems of pure science. The industry asserts that pure and applied science are one and indivisible.

Scientific literature, apart from technical journals and the Transactions of various institutions, dealing with the fundamentals of the processes and control of manufacture of towns' gas is not at present very extensive. The volumes under review, together with Meade's "Modern Gasworks Practice" in the same series, and Prof. Bone's "Coal and its Scientific Uses," constitute practically the only modern English works dealing specifically with the scientific and other problems of the gas industry.

(1) Consider the magnitude of the industry. We learn from Mr. Evetts's book that in the United Kingdom the public supply of gas is in the hands of about 1630 undertakings. About 20 million tons of coal and 65 million gallons of oil are employed annually in the manufacture of gas in the country. By-products of

carbonisation amount to 10 million tons of coke, 180 million gallons of tar, 170,000 tons of sulphate of ammonia, and 45,000 tons of sulphur annually. About 87 per cent. of street lamps in the country are lit by gas. The annual make of gas is approximately 1200 million therms supplied to consumers through about 8 million meters. The figures are clamant for the maintenance of a due sense of proportion in criticism of the industry. We commend them to the notice of any inclined to regard the gasworks as the original home of the three-card trick, and the gasometer as the present-day residence of the Borgias.

Mr. Evetts has produced an extremely clear and readable account of the legislative and administrative aspects of the gas industry. Primarily intended to meet the requirements of the student, the junior assistant, and others desirous of qualifying for high administrative posts in the industry, the book will be welcomed by a much wider circle of readers.

The provisions of the Gas Regulation Act, 1920, enabling gas to be supplied and sold on the basis of its potential thermal value, are set out in Chapter 2. Although from the date of the publication by the Board of Trade of the brochure on Gas Standards the gas industry generally welcomed the suggested new method of supply (p. 34), it should be remarked that at a somewhat earlier date such suggestions were regarded favourably only by a very small minority of representatives of the gas industry considering the subject. The supply and sale of gas on the only conceivable scientific basis, namely, on a thermal basis, having regard to present-day uses of gas, we owe to the Board of Trade. The electrical unit of energy supply is termed the Board of Trade Unit. We suggest that correspondingly the unit of supply of gaseous energy should be designated the Board of Trade Therm.

Among the matters dealt with by Mr. Evetts are: the sliding scale of gas charges, parliamentary procedure when applying for a Bill, the model Bill, repairs and depreciation, hirings and fittings, arbitration and other workaday matters. Chapter 8, dealing with financial aspects of the sale of gas by therms, is a clear statement of the numerous facts to be taken into consideration before a calorific value is declared. Advocates of the supply of low-grade gas should ponder well the tables on p. 242, giving the costs of mains and the pressures necessary to deliver a definite quantity of energy in the form of gases of various calorific values. In this connexion we may remark that such changes in declared calorific value as have recently occurred have all been in the direction of supplying gas of higher calorific value.

(2) Dr. Weyman's book on modern gasworks chemistry describes the methods employed in the control of plant and processes employed in the manufacture of towns' gas. Chapters are devoted to coal, carbonisation, coke, refractory and insulating materials, tar, ammonia, oxide purification, steam raising, water supply, and lubricants. A great amount of work has gone to the collection of the very large number of analytical and other tests comprised in the volume We regret that frequently these are not sufficiently detailed or clearly described to afford working instructions. Occasionally, and more especially in regard to what would be regarded as essentially physical tests, the descriptions are inaccurate or meaningless. As examples, we would refer to the calorimetric radiation correction (p. 27), the standardisation of the Wanner pyrometer (p. 56), and the determination of thermal conductivity (p. 74). It is certain that the methods described for the determination of the thermal conductivities of materials will not yield results of much value in the hands of the works chemist. This class of work should, we think, for the present, until the gas industry is equipped with its own large central testing establishment, be allocated to the National Physical Laboratory. In any case, if this section of the book is to be retained in later editions, it should include a description of the simpler flow methods, developed at the National Physical Laboratory for the determination of thermal conductivity, and probably more suitable for adoption in industrial laboratories.

(3) Dr. Levy's work on gasworks recorders is the complement of Dr. Weyman's. Control of chemical processes can be based upon the results of snap-tests or the indications of recording devices. There is much to be said for both methods. Painful experience with some recorders forces the present writer to the unfortunate conclusion that generally the former method is to be preferred to the latter. Individual observers suffer from their "personal equations." Recording devices are not without their idiosyncrasies. Their value and trustworthiness are to be determined by the "acid test": How far is the record influenced by, and *only* by, variation in the characteristic to be recorded? Frequently the influence of disturbing factors, such as friction, temperature, and the rest, are completely overlooked in the design of such instruments.

Pressure and vacuum gauges, pyrometers, gravitometers, gas analysis and volume recorders, and densimeters are among the recorders discussed in this volume. The activity, born of the Gas Regulation Act, 1920, among makers of scientific instruments is evidenced by the chapter devoted to recording gas calorimeters. Prof. Boys's instrument, incorporating many novel features and points of geometric design, is worthy of the close attention of scientific instrument makers generally. Incidentally it may be mentioned that an important feature of this recorder, namely, that the calorific value is recorded in strict relation to the chart ruling, however the chart may be displaced on the drum, is omitted from the description of the chart on p. 127. The electrical flow meter of C. C. Thomas described on p. 208 *et seq.* is finding extensive application in industry, more especially in America. In all descriptions of this instrument with which we are acquainted, it appears to have been overlooked that the device is merely an application of the constant flow method of calorimetry introduced by Prof. Callendar, and is one more in the lengthy and lengthening list of contributions—not always acknowledged—made by pure to applied science. Considering that the platinum resistance thermometer is among the most accurate of all indicating or recording instruments, it is disappointing to find its calibration inaccurately described on p. 62 and the variation of the resistance of platinum with temperature wrongly given in Fig. 56.

The main defect of the present volume is what we may be pardoned for describing as its apparent partisan character. About one-third of the instruments described are the products of a single firm. This is certainly unjustifiable in a work claiming, according to the preface, to describe all recording instruments of utility in gas engineering. We are acquainted with at least five types of recording pyrometers which go unmentioned although they are of utility at least equal to that of any described. Scant justice is done to certain forms of carbon dioxide recorders, to depth gauges, to water or steam meters. The recording specialities of one firm are referred to in the advertisement pages included in the volume but are not found in the text! We register our protest against this growing tendency in English scientific literature of a certain type.

(4) Under the Gas Regulation Act of 1920, the gas undertaking is interested in the supply of gas right up to the point of combustion of the gas in the burner. Mr. Walter Hole, from his experience as superintendent of the City of Leeds Gas Mains and Distribution Department, is, we think, as well qualified as any one within the industry to undertake the task of compiling a standard work on the subject of gas distribution. That a fourth edition of his work has been called for is eloquent testimony that it supplied a need felt in the industry. We would suggest, however, that the subject of gas distribution is so large that a treatise to be adequate must be the result of the co-operation of a number of experts in its various branches. In these days of specialisation it is not to be anticipated that a single individual will be able to deal adequately with, *e.g.*, the jointing of steel mains and the laws of flow of gases in pipes. The result of such an attempt might be foreseen and is evident in the present volume. The section devoted to main-laying is excellent and constitutes the best part of the volume. That devoted to a theoretical discussion of the flow of gases in pipes is inaccurate and altogether inadequate. It would be well, we think, to include the work of Stanton and Pannell and the empirical formula deduced by Lees from their results in this section.

New chapters on inferential meters and gas for industrial purposes have been included. The former is not entirely adequate. The form of Pitot tube developed as the result of work carried out at the National Physical Laboratory is quite incorrectly attributed to Griggs. This error will serve to illustrate the author's apparent general lack of acquaintance with the more strictly scientific aspects of the subjects of gas distribution. The chapter on gas for industrial purposes is wholly commendable and illustrates the great development which has occurred within recent years in this direction, a development very much accelerated by the call for munitions during the War.

Summing up our impressions after carefully reading the four volumes, we would say that the gas industry has at long last started on the way to provide itself with a scientific and technical literature which shall be in some measure adequate to its needs and deserts. The four volumes here briefly reviewed stand in serious need of overhauling, and we suggest that when a further edition of any of the volumes is called for, the proof-reading should be a little more carefully done. Grammatical errors and split infinitives are in some of the volumes almost as thick as "leaves in Vallombrosa," and we are tempted to infer that the gas industry has its own peculiar variant of Kings' English. The prices of the volumes are, even in these days of inflated index figures, exceedingly high. A considerable portion of the text and illustrations in Mr. Hole's and Dr. Levy's volumes is available gratis in the form of trade circulars, and we believe that these circulars will, owing to the high price of issue of the volumes, continue to be the main source of information consulted by the great majority interested in gas distribution and gas-works recorders. J. S. G. THOMAS.

The Earth under the Rule of Man.

Man as a Geological Agent: An Account of His Actions on Inanimate Nature. By Dr. R. L. Sherlock. Pp. 372. (London: H. F. and G. Witherby, 1922.) 20*s.* net.

THE Human period of the Quaternary era has set in. Disregarding epochs of the Pleistocene or of earlier periods in which man has left traces of his existence, his activity may be said to have begun when a clear field was given for migration. His rule on the earth's surface was assured by the disappearance of continental glaciation from the temperate zones. Henceforward, he began seriously to modify the earth. The improvement of the entrance to a cave was probably his first essay in denudation; the building of a barricade against wild beasts foreshadowed the vast works of transport and accumulation that are traceable in the Pyramids or in Cuzco.

By turning up the soil with pointed sticks, and later with some primitive form of plough, man assisted natural agents in the disintegration of hard rocks. As the soil developed under culture, with a constant renewal of its air-ways and water-ways, the subsoil in humid climates became modified in an opposite direction. Its interstices were choked by fine material washed in from above. There was a greater retention of water in the overlying soil, and acres that at one time were liable to run dry became available for the continuous growth of plants. When a patch became poor and temporarily exhausted, the early and unskilled cultivator moved to some adjacent area, just as the Berber of the Tell, with his camel-plough, or the Bantu in some forest-clearing, with his wooden hoe, is apt to do at the present day. In this way the earth was primarily and profoundly influenced by man. Let us remember that if our "civilisation" comes to us from the crowded life of cities, our "culture" reaches farther back, and was born with the first tillage of the fields.

This widely spread and continuous attack upon the land-surface does not appeal to Dr. Sherlock so much as might have been expected. He is more concerned with the localised and spectacular results of engineering pertinacity in recent centuries. These lend themselves to statistical treatment, and they can be compared with the slowly cumulative effects of natural, that is to say non-human, agents. Dr. Sherlock has brought together a large amount of curious information, and is able to tell us (p. 24) the total output of coal from Great Britain between 1500 and 1913 A.D., the area (p. 110) of England and Wales under pavements in 1908, and the height of the brick structure (p. 236) that forms the famous mound of Babylon. A fine example of his zeal for calculation appears on p. 73, where, by the use of average specific gravities, he records the output of quarries of eleven types of material during nineteen years in cubic yards in place of tons; 2·75, however, seems a slip for 2·25 in the case of gypsum; and is it scientific to use for quarried ironstone a factor so precisely stated as 4·017?

It was well worth while to direct attention to the enormous bulk of the artificial hills of slag or shale that are still growing in our mining areas. The illustrations facing pp. 203 and 207 are convincing evidence of the activity of man. The modification of an area of complex structure by the spread of a city over it is excellently typified in the chapter on London. The story of the origin of Moorfields in water that was banked up against the Roman Wall, and of the replacement of the alluvial mud of the Wall Brook and the Langbourne Water by the subterranean floors of some of our most monumental city buildings, might have been told in even greater detail. Dr. Sherlock, however, is not to be lured into the picturesque. He does not step aside to mention the lining of corridors in modern offices and hotels with the spoils of Egypt and Numidia, with slabs of imperial porphyry, "fiammeggiante come sangue," and with pale marbles voluptuously veined; or the accumulation of exotic blocks, exceeding in variety and length of travel the erratics of an ice-age, which man has brought together to deck, say, San Paolo fuori le Mura, even in an epoch of nineteenth-century restoration. The amount of Caen stone in the south of England, or of the corresponding oolite from Portland in the grey limestone areas of Ireland, suggests similar reflections. A conspicuous example of man's energy in geological transport is to be found in the Portuguese stone that was brought in carracks round the Cape to build the jutting fort on the coral shore at Moçambique.

Though the reader's imagination is not touched by Dr. Sherlock, plenty of facts are given on which to found an outlook. A sense of accurate hard work pervades the volume. The material has been quarried out, and the result of its accumulation is neither a slag-heap nor a cathedral. We have noticed only one misprint ("Berschlag" for "Beyschlag"), and few matters that the geologist could reasonably question. We wish that we could agree with the optimistic statement on p. 112 that "no sooner is a part of the road-covering destroyed than more material is brought from a quarry to replace it." In illustration of the denuding effect of ordinary traffic, a photograph of one of the deeply cut by-ways in the Folkestone Sand of Surrey would have been welcome as a touch of rural England. It would refresh one after reading of the 156,000,000 cubic yards of comminuted quartz-conglomerate on the Rand.

The construction of the volume is such that its main lines suggest attractive by-ways. The amazing transference of rock-material for agricultural purposes from Chile, Christmas Island, or the desert-edge of Gafsa, might well deserve a mention. The destructive action of man-made sulphuric acid in the atmosphere of our industrial towns has been pointed out by Mr. J. A. Howe. Dr. Sherlock, however, has provided us with ample material for developing the subject along such paths as may appeal to us most nearly. GRENVILLE A. J. COLE.

Comparative Psychology.

Handbuch der vergleichenden Psychologie. Herausgegeben von Gustav Kafka. Band 1: *Die Entwicklungsstufen des Seelenlebens.* Pp. viii + 526. Band 2: *Die Funktionen des normalen Seelenlebens.* Pp. viii + 513. Band 3: *Die Funktionen des abnormen Seelenlebens.* Pp. viii + 515. (München: Ernest Reinhardt, 1922.)

THE present is often said to be a psychological age, and certainly the recent rapid multiplication of psychological books and lectures would seem to justify the above statement. One happy result of the stimulus which popularity has given to the production of psychological literature has been to make that literature extensive and varied. Nevertheless a survey of that literature shows that the psychologist's library is by no means adequate to his needs. There are at least two regrettable deficiencies, deficiencies which are more obvious in English than in German psychological literature. There is, on one hand, no large-size and generally accredited work on theoretical or pure psychology, a work sympathetically mediatory between the several divergent schools of contemporary psychological thought, a work which provides a basis of theory for the co-ordination of the as yet somewhat scattered results reached in the various fields of psychological research. There are in existence many first drafts of and essays towards such a work, but none is detailed and comprehensive enough, apart from the fact that none of them can claim anything like general agreement; and this deficiency, however unavoidable, however much a symptom of scientific health, is obviously very disconcerting to students.

The second deficiency, the one most in question here, is the absence of a sustained and comprehensive attempt to describe the world of living beings from the psychological point of view. Twenty years ago this would have seemed an impossible, if not a thankless task. To-day it is at least possible to make a beginning. For one of the many indications of the psychologicalness (if the word may be permitted) of this age has been and still is the rapid and unresting invasion of one realm after another of concrete experience by the psychologist. From the somewhat supermundane and, to many, jejune science, closely associated with metaphysics, which it was in the last century, psychology has developed into a science which touches practical interests and activities at a thousand points. Education and industry, art and society, war and peace, all have begun to be at least discussed and often treated from the psychological point of view. And one result of this successful ramification has been the accumulation of material for such a description of the world.

What a fascinating gazetteer that would be, a psychological gazetteer of the world! A survey of the world through the eyes and from the vantage point of the psychologist! What tantalising glimpses one has of a psychological description of politics, of business, of courtship and marriage. . . . Those preserves of opinion which, as Mr. Trotter says, are deemed too lofty for knowledge and are reserved for conviction, would no longer be able to keep their sacrosanct aloofness. One would seek to understand not only the origin and persistence of the opinions but also the taboo itself. All phenomena, oaths, and tea-parties, morality and social rank, would be approached from the point of view of psychological interpretation. Ethical and æsthetic prejudgments would neither deter nor mislead, they would be explained. One would psychologise on a cosmic scale, never stopping till the psychology of the psychologist himself had been written.

There is scant prospect, alas, of anything of the quality and scale of the above for a very long time to come. Intensively and extensively contemporary psychology is not equal to such a task. On one hand, psychology, despite its recent advances, has not yet explored, much less cultivated, the full extent of its territory. Progress has been ragged, and while here the workers are many and progress rapid, there it is well if a bare seisin has been taken. On the other hand, psychological theory is as yet too limited and too sketchy, neither strong enough nor comprehensive enough, for the organisation and interpretation of the vast mass of data with which it would have to grapple.

But half a loaf is better than no bread, and if even relative finality cannot be looked for, yet a beginning is feasible. If no beginning has so far been made, with the possible exception of the late Wilhelm Wundt's obsolescent and inadequately conceived "Völkerpsychologie," the fault must lie with the necessary specialisation of contemporary psychology. The individual psychologist has been marooned, as it were, in his own field of work, ample though that field has often been; his tentatives towards communication and co-operation have been baffled by the immensity of the science, and few have had the courage and the vision even briefly and imperfectly to envisage that science as an articulate whole. So that even the little that was possible has been left undone, and the reader who wishes to gain even a cursory and incomplete conspectus of psychological experience must pursue his purpose through scores of ill-related and narrow volumes.

The student's labours have been considerably lightened, and the present unfortunate and unnecessary state of affairs significantly improved, by a recently published work. This is the "Manual of Comparative Psychology" edited by Prof. Gustav Kafka, of Munich, to which twelve psychologists, including himself, have contributed. The work itself is divided into twelve sections, each section constituting a specific department of psychology and being written by a specialist in that department. These sections are grouped, somewhat unequally, into three groups, each group corresponding to a volume of some five hundred pages. The three groups are: The Evolution of Mind (Animals, Primitive Mankind, and Children); the Functions of the Normal Mind (Language, Religion, Art, Society, and Vocational Psychology); and the Functions of the Abnormal Mind (Psychopathology, Sex, Dreams, and Criminals).

This list sufficiently indicates the scope of the work. It is easy to find omissions: law, industry, and morality are inadequately represented, for example, while the editor himself deplores the absence of a section on the psychology of science, an omission due to his inability to find any one to write the section. It is easy also to find fault with the arrangement of the subject-matter. To mention one point only, it is surely not justifiable to give the impression that sex and dreams are abnormalities. One might again stress the occasional overlapping, the occasional unevenness of treatment and of point of view, and the more than occasional stodginess of manner, due largely to excessive compression on the one hand, and to theoretical incoherence on the other hand. But this is a pioneer work and must be judged leniently. If the reader brings an active and organising mind to its perusal, then the defects will be neutralised and the solid qualities of the work appreciated. For this reason one hesitates to recommend the work to the general reader, above all to the general reader who knows little or no psychology, and to whom an overloaded and viscous style is repellent. To those better versed in psychology its comprehensiveness, its accuracy, and its excellent bibliographies will make their appeal. They will be grateful for the compact account of the psychology of language. They will be glad to have Sante de Sanctis' views on dreams, inasmuch as they are the views of a man who began the study of dreams before Freud published his "Traumdeutung"; and they will be appreciative of and grateful for much else in this timely work. The fact that it is written in German will constitute but one more reason for regret that an international language for science has not long since made the peculiar aptitude of the German for this type of work the common property of mankind.

Our Bookshelf.

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. II. Abteilung, 1 Teil: Thallophyten. Band 6: Bakterien und Strahlenpilze. Von Prof. Dr. Rudolf Lieske. Pp. iv+88. (Berlin: Gebrüder Borntraeger, 1922.) 4*s.* 6*d.*

The purpose of this handbook, which is to be comprised in a series of monographs by specialists in the various branches of the subject, is to give, in brief compass, a critical presentation of the present state of our knowledge of plant anatomy and cytology. In the volume before us, Prof. Rudolph Lieske, of the University of Heidelberg, has brought together, in a commendably brief and useful form, a critical digest of what is at present known of the morphology of the bacteria and ray-fungi (Actinomycetes). The first part of the book contains an account of the bacteria. In reference to the nuclei and nuclear structures which have been so frequently described, it is concluded that, although there can be no doubt about the existence of minute granules with nuclear characteristics, the presence of true nuclei in the bacteria has by no means been proved. The author has some interesting observations upon the recently described symplastic stage in bacterial development, and on the so-called sexual reproduction of bacteria. Among other topics dealt with are pleomorphism and variability, filtrable viruses, and mycobacteria.

In the second part of the volume the ray-fungi are dealt with. In discussing the systematic position of the group it is pointed out these organisms have certain characteristics in common both with bacteria and fungi, and that they must be looked upon as an independent group standing between the two. The various forms of the Actinomycetes present an astonishing variability both in morphological and physiological peculiarities, and the characters which have been used by various observers to discriminate species are so inconstant that no dependence can be placed upon them.

A literature list accompanies each part of the work, and there is a good index.

Mathematics and Physical Science in Classical Antiquity. By D. C. Macgregor. Translated from the German of J. L. Heiberg. (Chapters in the History of Science, II.). Pp. 110. (London: Oxford University Press, 1922.) 2*s.* 6*d.* net.

This volume gives a general survey of the science of classical antiquity, laying special stress on the mathematical and physical aspects. It opens with an account of the Ionian natural philosophy, pointing out that science is the development of early attempts of man to see his way in the world outside. Next there is a chapter on the achievements of the Pythagorean school, followed by two others on the progress made in the fifth century B.C. One of these is on mathematics, still under the influence of Pythagoras, and the other on medicine, which then reached a level not surpassed before the Alexandrian age. The work of Plato and Aristotle is adequately dealt with, while the longest chapter in the book is assigned to Euclid, Archimedes, and the Alexandrian school. In the period of decline which followed (second and first centuries B.C.)

only medicine made any real progress, and a four-page chapter is sufficient to record the work of the Romans. The last chapter, a long one, is devoted to Greek scientific literature of the Byzantine empire, it being stated that the founders of modern science, such as Galileo, Copernicus, and Newton, learnt from the Greeks not only particular results but also the very meaning of science.

Naturally Prof. Heiberg's little book makes no pretence of being a complete history of science in classical antiquity. It puts the achievements of the different schools of thought into a true perspective, and the language throughout is free from technicalities. The book would be improved by the insertion of more dates, even when these are only known approximately. (A companion volume deals more fully with the medical and biological sides of the subject.) W. E. H. B.

Tested Methods of Metallurgical Analysis (Non-Ferrous). By S. Pile and R. Johnston. Pp. 128. (London: H. F. and G. Witherby, 1922.) 7*s.* 6*d.* net.

In referring to the literature of metallurgical analysis the student, and even the worker of experience, frequently finds himself at a loss to select, from the mass of alternative detail offered, a method suited to his immediate requirements. The authors of the present work, while disclaiming any novelty in the methods given, have collected together a series of well-tried methods of which they have had personal experience. The book deals mainly with commercial metals and their more important alloys. It opens with a few introductory remarks on general analytical procedure, and on sampling. In the latter no mention is made of the frequent necessity for rejecting the first few drillings of a bar to avoid the introduction of skin impurities, as distinct, of course, from segregated elements. The suggestion of dissolving up a large quantity of metal, and working on an aliquot portion of the solution, is a good one, and worthy of more general adoption. The metals are dealt with in alphabetical order, several good methods being given for each metal, and special attention is paid to details of manipulation. The inclusion of "moisture" among the determinations is rendered possible by the somewhat "scrappy" reference to fuels and oils. A similar extension in the case of sulphur is treated at greater length. No mention is made of gold or its alloys.

With some exceptions, perhaps of secondary importance, the book is a sound and careful compilation, and should meet all the requirements of those needing, at the working bench, a trustworthy guide to assays coming within the scope of the book, familiar or otherwise.

Faune de France. 4: *Sipunculiens, Échiuriens, Priapuliens.* Par Prof. L. Cuénot. Pp. 31. (Paris: P. Lechevalier, 1922.) 3 francs.

To this excellent series, promoted by a federation of the French natural history societies, Prof. Cuénot, of Nancy, contributes an account of the curious marine animals that used to be classed together as Gephyrea. Nowadays it is supposed that the resemblances between the three groups mentioned in the title are due to convergence, and that each group was derived independently from some primitive ancestor of the annelids. Prof. Cuénot, whose writings of twenty years ago on some of these creatures are well known to zoologists, has here given a clear, interesting, and well-illustrated summary of the species living round the coasts of France. British zoologists, though they have the works of Shipley and the more recent paper by Southern, may none the less welcome this convenient aid to the study of a remarkable assemblage. F. A. B.

Manuel de filature. Par F. Rubigny. (Bibliothèque Professionnelle.) Pp. 366. (Paris: J. B. Baillière et fils, 1922.) 10 francs.

The volume under notice is one of a series of technological works, written primarily for the use of workers in the several industries, and deals with the spinning of all kinds of fibres, including asbestos and artificial silk, and also with the spinning of paper yarn. The treatment follows similar lines to those adopted by other writers on spinning, but with rather more attention to function and less description of machinery details than is the case with English works on the subject. Though this book cannot, any more than similar works on spinning technique, be taken as a trustworthy guide with respect to the raw materials, yet considering the wide field covered in less than 400 octavo pages, the treatment is otherwise remarkably adequate; and the book should be found a useful supplement to the usual works on spinning.

Cours de physique mathématique de la Faculté des Sciences. Par Prof. J. Boussinesq. Compléments au tome 3: Conciliation du véritable déterminisme mécanique avec l'existence de la vie et de la liberté morale. Pp. xlviii + 217. (Paris: Gauthier-Villars et Cie, 1922.) 30 francs.

This book is in the nature of a supplement to a complete course of mathematical physics by the University of Paris professor. It contains an extraordinary variety of matter, not very well arranged, but its main purpose is to round off a natural philosophy course by including, or rather by reconciling, the mechanism of physical nature with the indeterminism of life and consciousness. To a certain extent this has been the intellectual problem since Leibniz. Prof. Boussinesq can scarcely be said to claim to bring forward anything distinctively new, but he discusses the problem with full scientific knowledge and keen philosophical interest.

Smith's Intermediate Chemistry. Revised and rewritten by Prof. J. Kendall and E. E. Slosson. Pp. xv + 566. (New York: The Century Co.; London: G. Bell and Sons, Ltd., 1922.) 8*s.* 6*d.* net.

There can be no doubt that this book, the first edition of which was reviewed in Nature of October 14, 1920, p. 208, has been greatly improved by revision. It is now more balanced in treatment, is very well printed and bound, and is probably the best elementary treatise on chemistry of the day. The inaccurate historical note on oxygen (p. 28), which was mentioned in the former review, has been toned down, but is still somewhat incorrect. Apart from the very clear and modern account of the chemistry of the common elements, the book contains a large number of brief notes on important matters (vitamins, enzymes, atomic structure, isotopes) not often met with in elementary manuals.

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.*]

Origin of Radioactive Disintegration.

IN a letter to NATURE of September 16, 1922 (vol. 110, p. 379) R. N. Pease directs attention to the possibility that the radioactivity of the heaviest elements may be due to the disturbing effect of the electrons in the atom. This view may be traced back to the time of the discovery of radioactivity (cf. J. J. Thomson, *Phil. Mag.* 7, 265, 1904, and Lord Kelvin, *Phil. Mag.* 8, 525, 1904). The problem, however, has been seriously complicated by the circumstance that, on the basis of ordinary mechanics and electrodynamics, the outstanding difficulty has not so much been to understand that radioactive disintegration can occur as to understand the simple law of radioactive decay. For the latter question, it seems that the development of the quantum theory has prepared the way to a deeper insight in the sense that the same law may be shown to apply to transition processes between stationary states of quantised systems.

On the basis of the quantum postulates alone it is an open question whether the nuclear instability is a strictly spontaneous process solely dependent upon the state of the nucleus itself, or whether external influences also play an essential part. A tentative argument in favour of the latter view is perhaps afforded by the fact that the life-periods of the elements at the beginning of the disintegration series are very large. This fact suggests the idea that the nuclei may be intrinsically stable and the radioactivity of these elements induced by the action of an external field of force, the origin of which may be looked for in the surrounding electrons. The regular variation in the life-period of successive elements in the disintegration series seems to indicate that the disintegration, when once initiated, proceeds spontaneously until a stable element is reached. On the other hand, the occurrence of radioactivity in the elements of low atomic numbers (rubidium and potassium) might be due to an enhanced efficiency of the perturbations due to some sort of resonance in the interaction between the nuclear and the electronic motion.

The force exerted by the electrons at a point in, or close to, the atomic nucleus will increase rapidly with increasing atomic number on account of the decreasing dimensions of the electronic orbits belonging to a permanent group. It will, however, in addition, depend intimately on the nature of the electronic configuration. If this configuration at every moment exhibits central symmetry, the forces from the electrons will to a large extent neutralise each other. The case is essentially different in the recent theory of Bohr, according to which the electrons belonging to a particular group and moving in eccentric orbits will approach the nucleus in succession. The shortest distance from the nucleus will be attained by the electrons moving in orbits with azimuthal quantum number equal to 1, and will then be given by

$$d = \frac{d_0}{2N}(1 - \alpha^2 N^2) \quad . \quad . \quad . \quad (1)$$

approximately. Here N is atomic number, d_0 the radius of the orbit in the normal hydrogen atom, and $\alpha = \frac{2\pi e^2}{hc} = 7{\cdot}2 \times 10^{-3}$ is the constant occurring in the theory of the fine structure of hydrogen lines. For the uranium atom the above formula gives $d = 15 \times 10^{-12}$ cm. On the other hand, the inferior limit for the diameter of the uranium nucleus, derived from the energy of the α-particles from uranium on assuming this energy to be due to the electrostatic repulsion of the nucleus, comes out of the same order of magnitude as the above value of d. At the moment of closest approach these electrons will thus exert forces upon the individual particles of the nucleus which may be of the same order of magnitude as the electrostatic attraction or repulsion between the particles themselves. For still larger atomic numbers, d will rapidly decrease while the nuclear dimensions will be expected to increase. It is therefore seen that for some atomic number not far ahead of that of uranium the electrons in question would have to pass quite close to the nucleus, and thus exert large perturbing forces on the nuclear particles. For still larger atomic numbers a motion for which the nuclear field is treated as due to a point charge would become impossible as the electrons in question would have to collide with the nucleus. On the whole, it does not appear excluded that the presence of radioactivity among the heaviest known elements as well as the apparent absence of elements of higher atomic numbers may be connected with some sort of interaction between the nuclear and the external electrons.

The efficiency of this interaction will be expected to depend intimately on certain resonance conditions, as is the case for ordinary mechanical systems. The frequencies of the motion of the nucleus must in general be expected to be of an altogether higher order of magnitude than the frequencies in the motion of the electrons; but there remains the possibility that the nucleus as a whole will rotate and this rotational frequency may in some cases be comparable with some electronic frequency. The case when the nucleus rotates with an angular momentum equal to $h/2\pi$ is of special interest, as this value appears to be associated with the most stable state of quantised systems. The rotational frequency w may then be estimated from the expression

$$w = \frac{h}{4\pi^2} \cdot \frac{1}{Ma^2}, \quad . \quad . \quad . \quad (2)$$

where M and a are the nuclear mass and radius of gyration about the axis of rotation. Assuming the nuclear dimensions to increase from about 8×10^{-13} cm. in helium (Rutherford and Chadwick) to about 6×10^{-12} cm. in uranium (cf. above) this frequency is found to decrease from about 10^{20} sec.$^{-1}$ in helium to about 10^{16} sec.$^{-1}$ in uranium. The latter value is essentially larger than the value to be expected for valency electrons. This is also necessary in order to understand the fact that the radioactive properties hitherto on record are independent of chemical combinations. It will further be found compatible with the assumptions regarding the nuclear dimensions to assume the frequencies of nuclear rotation in potassium and rubidium to be of the same order of magnitude as the electronic frequencies of the K and the L electrons respectively in these elements.

The above considerations, however, are to be regarded merely as tentative suggestions, and our knowledge of nuclear structure is probably far too scanty to permit of any definite conclusions concerning these questions at present.

S. ROSSELAND.

Copenhagen, Institut for teoretisk Fysik,
February 12.

The New Marine Biological Research Station of the Bergen Museum.

FOR close upon one hundred years researches regarding marine fauna have been a prominent part of the work carried out by the Bergen Museum. The first biological station in Norway was built in the year of 1891 and was attached to the museum. On account, however, of the expansion of the city of Bergen, the pollution of the salt-water supply for the station gradually increased to such an extent that the biological work there had to be abandoned.

By the generosity of private donors, who realised that the fine traditions of the maritime research work carried out at Bergen should be maintained, the Trustees of the Bergen Museum have been enabled to build a new station. The biological station (Fig. 1) is now situated on the island of Herdla, about seventeen miles from Bergen. The station is thus right in the centre of one of the richest and most promising fields for research of the west coast of Norway, well known also through the investigations of such British naturalists as Norman, Jeffreys, Harmer, Punnett, and others. The open sea, the deep fjords, and the narrow sounds with their strong currents, offer here the most varied and changing conditions of life for marine fauna, which accordingly is extraordinarily rich and well represented.

FIG. 1.—Marine Biological Station at Herdla, seen from the fjord.

Any biological condition typical of the west coast of Norway may be reached within less than two hours' sail from the station. The salt-water supply is taken from a depth of approximately 25 metres, which guarantees salt water of excellent quality and without appreciable changes in temperature and salinity. Thus are present the best conditions for experimental and embryological research.

The object of the station is to serve as a basis for scientific investigations, as well as for the international courses in marine biology which were held at the Bergen Museum for a number of years until 1914, and with a large participation from abroad. The station is open to naturalists of all nations. During the period in the summer when no courses are held, the station has tables for ten scientific workers besides the staff. During the winter there are tables for five only. Being situated close to the open sea, which never freezes, the station can be kept open all the year round, and thus offers good opportunities for collecting material during the winter months. The station contains the necessary accommodation for housing naturalists visiting it.

A 25-ton research vessel, the *Herman Friele*, is attached to the station, and is equipped with appliances for research down to a depth of 1500 metres. Moreover, the station is provided with a smaller open motor boat and various rowing-boats.

By the opening up of this new station, facilities are afforded for utilising again the particularly favourable conditions for marine biological investigation offered by the west coast of Norway. I shall be glad to reply to any inquiries regarding the station or the reservation of tables.

A. BRINKMANN.
(Director.)

Museet, Bergen, Norway.

Industrial Applications of the Microscope.

WHILE one reads with satisfaction in NATURE of February 17, p. 239, of the ever-increasing examples of the application of the microscope to industry, the fact remains that the use of the mineralogical microscope with the small amount of knowledge of crystal optics necessary has up to the present been practically disregarded.

In 1918 a considerable amount of work was done in this connexion dealing particularly with explosives, but the results were never published, and hence it is thought that the following example may be of interest.

It was proved quite definitely at the Ardeer Factory of Nobel's Explosives Company that the degree of nitration in guncotton and nitrocellulose could be ascertained directly by the optical properties of the product. Thus it was found that the birefringence of ordinary cotton fibre before nitration was strong and of a positive character. The same cotton after being fully nitrated showed strong birefringence but of a *negative* character, while cotton with an intermediate degree of nitration was shown to be practically isotropic.

It was found afterwards that a corresponding work had been carried out by Dr. Phil Hans Ambron in Germany, and he published a table giving the actual values and character of the birefringence of nitrated cellulose and also nitrated ramie or China grass. It is, of course, true that the degree of nitration can be obtained quicker and more accurately by means of a nitrometer, but the two lots of information differ widely. The nitrometer gives the average nitration of the whole sample while the microscope gives the actual nitration of separate fibres, and is therefore a valuable test of the homogeneity of the sample.

During the War, when acetone was unobtainable, a substitute had to be found as a solvent for nitrated cellulose in the making of cordite. Ether-alcohol was the substitute used. Now, while cellulose and almost any form of nitrated cellulose are soluble in acetone, ether-alcohol will only dissolve nitrated cellulose of a certain percentage nitration, and the homogeneous nitration of large samples of cotton was by no means easy or altogether certain, and hence the microscopic method should have been invaluable. The results of these experiments were obtained too late to be used on a large scale, but they certainly show an example of the class of information obtainable.

Another application of a rather humorous nature can also be cited. A large consignment arrived in the factory of what was called ground silica. This was sent to the analytical department and its percentage of silica ascertained. It was pointed out, however, that the value of ground silica did not lie in the purity of the material but in its fineness and homogeneity. This was tested both by elutriation and the microscope. The microscope revealed the fact that the material was nothing but an inferior sand, with very little grinding. Ground silica must, of course, always show conchoidal fracture and not rounded grains. This sample was also shown to contain the mineral glauconite actually replacing the tests in small fragments of foraminifera, and hence had during its formation been closely connected with the sea. The price per ton indicated that the material was supposed to have been obtained by the grinding of vein quartz.

The identification of asbestos has been published before, but it bears repeating. Platinised asbestos was extensively used in the sulphuric acid plant. The asbestos was originally supplied from the continent, but during the war this supply was not available. The South African asbestos or the mineral crocidolite was used as a substitute with very disastrous results. It was decided, therefore, that the nature of the original asbestos must be obtained by chemical analysis and all samples similarly tested. The chemical analysis of a complicated silicate like asbestos is a long and by no means easy process, as the asbestos is seldom free from other complicated silicates. Now, it was found by a very simple mineralogical test that the original sample was the mineral chrysotile, and by similar tests it was quite easy to ascertain which of the other samples was also chrysotile and to pick out the purest. In this way, a dozen samples were tested in two hours, whereas the chemical analysis had already been in hand for three months, and was likely at the same rate to take another six and give no information whatever.

The simple test for chrysotile was mounting it on a microscopic slide in mononitrobenzene and rotating it between crossed nicols. The refractive index was obtained by the Becke method. The refractive index together with the birefringence and optical character render the mineral quite distinct from any other sold as asbestos. These are three of the very many occasions that cropped up so frequently.

ASHLEY G. LOWNDES.

Marlborough College, Wilts.

Factors of Odorous Strength.

IN the letter from Mr. J. H. Kenneth published in NATURE of February 3, page 151, a relation is indicated between the odours of certain substances and specific gravity. If, however, we examine the boiling-points of the odorous constituents of the four oils mentioned, we find that in order of increasing vapour pressure the oils stand as follows: sandalwood (305), cedarwood (280), origanum (230), and terebene (160), the figures in brackets being the approximate boiling points. This order is precisely that represented by the specific gravity quoted by Mr. Kenneth.

I scarcely think the phenomenon with which Mr. Kenneth's letter deals, can safely be ascribed to the specific gravity of the oils, although possibly in this instance the specific gravity is a property concomitant with volatility. Volatility alone, however, does not afford a completely satisfactory explanation of this and many other phenomena connected with the smell of an odoriferous substance. There are at least four factors concerned, namely: (1) Volatility; (2) solubility in the aqueous layers in the nose; (3) solubility in the lipoid fats of the nose, and (4) chemical reaction with osmoceptors in the nose.

A substance which fails to satisfy any one or more of these factors is odourless, and it is obvious that variations in the factors will produce variations in both the strength and the quality of the odour.

T. H. DURRANS.

The Dyson Perrins Laboratory,
South Parks Road,
Oxford, February 6.

WITH reference to Mr. Kenneth's letter in NATURE of February 3, p. 151, I should like to point out that, if the "votes" be counted on a sort of proportional representation scheme by adding to the first votes for each substance half the second, a third of the third, and a quarter of the fourth, we get the following results in votes:

S.	C.	O.	T.
18·66	11·56	9·33	6·33

This result seems to me to enforce Mr. Kenneth's argument.

FRANK H. PERRYCOSTE.

Higher Shute Cottage, Polperro R.S.O.,
Cornwall, February 17.

The Life-Cycle of the Eel in Relation to Wegener's Hypothesis.

IN NATURE of January 27, p. 131, under the title "The Distribution of Life in the Southern Hemisphere, and its Bearing on Wegener's Hypothesis," an account is given of a discussion at a recent meeting of the Royal Society of South Africa on this question. Opinions were divided, the geologists suspending judgment, while the hypothesis was opposed on botanical and entomological grounds as being unnecessary. On the other hand, it was said that the most important zoological evidence in support of Wegener's theory was provided by the distribution of the isopod, Phreatoicus.

It seems to me that strong evidence in favour of Wegener's hypothesis is to be found in the life-history of the European freshwater eel, as revealed by the brilliant researches of Dr. J. Schmidt, of Copenhagen. For something like eighteen years Dr. Schmidt has been engaged on this subject. He has published numerous papers and has summarised his results in the Philosophical Transactions, published a year ago, and quite lately in NATURE (January 13). It will be sufficient for the present purpose to allude only to certain of his results.

Of the two freshwater eels of the North Atlantic, the American species spawns somewhat to the south and west of the spawning region of the European species, and the larvæ attain full size and, after metamorphosis, enter the freshwaters of the American coast when about one year old. On the other hand, the larvæ of the European species, originating more to the east but still in the same region, are transported by the Atlantic Drift and its continuations, aided perhaps by their own efforts, it may be for thousands of miles, as shown in the chart, p. 51 of the article in NATURE of January 13. Still more to the point, the larvæ are about three years old when they become transformed into elvers and enter freshwaters. A larval life so extremely prolonged, as Dr. Schmidt points out, is quite unique. The rate of growth, moreover, is extraordinarily slow. At full size, after about three years' growth, the larvæ are approximately three inches long, although the temperature of the water in which they are immersed is comparatively high. In our own waters with much lower temperatures most young fishes would attain a corresponding length in as many months. The extremely slow growth of the larvæ of the European eel is thus an adaptation to the prolonged journey.

It is scarcely possible to understand this unique phase in the life cycle of the European eel on the hypothesis that the geographical conditions were formerly the same as now exist. But if Wegener's theory be accepted, the explanation is simple. As the coasts slowly receded from one another the larval life of what became the European species was more and more prolonged by natural selection in correspondence with the greater distance to be traversed. T. Wemyss Fulton.

41 Queen's Road, Aberdeen,
February 16.

The Stoat's Winter Pelage.

Sir Herbert Maxwell's letter on the above in Nature of February 17, p. 220, raises points of great interest. Presumably if his glacial explanation be correct, stoats taken from the Scottish Highlands to the south of England will still become white in the winter; whereas stoats brought from the southern counties to the north of Britain will remain the same colour the year round. Has this ever been put to the test?

It would be instructive to know whether winter coats intermediate in shade between brown and cream-white are ever assumed. I ask this from the point of view of mutation, which is so much to the fore at present. Have, for example, circumpolar white animals arisen from coloured ones through chance albinos being preserved and increased by Mendelian segregation, or have they appeared through the selection of paler and paler forms leading eventually up to white?

Then again, taking Sir Herbert Maxwell's explanation as correct, have we not here an example revealing how slowly evolution may work? The elimination of the arctic winter garb of the stoat in Britain is not yet complete, though some thousands of years at least must have elapsed since the last ice age.

One more point: Is the British stoat as regards its pelage reverting to the pre-glacial condition, and if so, how does this harmonise with the view that evolution is irreversible? John Parkin.

The Gill, Brayton, Cumberland.

Sir Herbert Maxwell's attractive thesis (Nature, February 17, p. 220), that latitude and not winter temperature regulates the seasonal change of the stoat's pelage from brown to white, does not meet all the facts of the case. Islay is farther north than Monreith, and yet in Islay a large proportion of the stoats retain their summer colour throughout the winter.

Having made arrangements some time ago to obtain specimens of the Islay stoat, regarded by Mr. Gerrit Miller as a distinct race, I was struck by the fact that individuals killed in December and February were in summer coat. This suggested inquiry as to the usual course of events in the island, and Mr. Macdonald reported that there white winter stoats are rather the exception than the rule: that of more than 20 stoats he had killed during the winter of 1921–22, only one was entirely white, although in the previous winter the proportion was higher, about six being white; but that only in exceptional years did the proportion of white individuals attain to about half of the total number killed.

Now the latitude of Edinburgh is not far off that of Islay, yet my impression is that here almost all the stoats become white in a normal winter.

These and other facts strengthen the old idea that climate is somehow involved in the colour-change, which seems also to depend to some extent on the condition of the individual animal.

James Ritchie.

The Royal Scottish Museum,
Edinburgh, February 21.

Sir Herbert Maxwell, in Nature of February 17, p. 220, directed attention to what he considered the conditions determining the winter change of colour in stoats, and inferred that the tendency to undergo such a change is usually the inherited characteristic of some particular strain or breed, rather than the outcome of any special present local severity of climate. He said the effect was most marked in the Highlands of Scotland and diminished regularly as one travelled south, until on reaching Cornwall the winter blanching seemed almost entirely in abeyance.

Since his observations appear to be confined to the island of Great Britain, Sir Herbert may be interested to learn that as a boy at Jersey, about the year 1880, I happened to come across a white stoat. This was shot by a neighbour, in St. Lawrence valley, and, after being stuffed, kept by us for some years. It represented a perfect ermine, the fur being pure white except for a black tail. I never heard of, or saw, any other specimen in Jersey, either white or brown. The case seems interesting, for the stoat belonged to a breed which must have been free from any extraneous admixture, particularly from the north, since that remote period in the past, when the French coast (on which the Channel Islands are situated) was finally separated from Great Britain by the English Channel. Further, the climate being mild and uniform, the tendency to assume a winter pelage can only have resulted from very ancient inheritance.

R. de J. F. Struthers.

Exeter College, Oxford.

The Subject Index to Periodicals.

May I add a few words of information to the appreciative review of the above publication which appeared in Nature of February 17, p. 214. Our headings are "The Subject Headings used in the Dictionary Catalogues of the Library of Congress" to which an annual supplement is published. These are linked up with the corresponding classes in the shelf-classification of that library. The advantage of this type of catalogue is that, if properly compiled, it combines system and uniformity with the property of immediate reference. It is in fact a class catalogue in which the headings are arranged in "index" order. Your reviewer's suggestion that we should print a list of the journals indexed in each Class List will be certainly adopted when our funds admit of it. Our Class Lists for 1915-16 contained such Lists as well as Authors' Indexes, and it was with the utmost regret that we were compelled to discontinue these features.

The following extract from an official letter now being circulated widely throughout the British Empire may interest some of your readers:

"In assuming responsibility for the Index the Council of the Library Association was actuated by the following considerations:

"(1) That, in view of the rapid growth of the periodical press, the analytical indexing of periodicals could be carried out with due regard to efficiency and economy only by co-operative effort.

"(2) That such co-operative publication should be controlled by a British professional body rather than be left to the enterprise of a foreign publisher.

"(3) That the Index should be compiled by trained library workers on a voluntary basis, and that the price should be fixed as nearly as possible to the cost of production, and without any idea of profit."

Every effort will now be made to bring the Subject Index up to date. We hope to complete the 1920 Class Lists this summer and commence the publication of the 1921 Lists in the autumn. For further particulars application should be made to the Hon. Secretary of the Library Association, Westminster Public Libraries, Buckingham Palace Road, S.W.

E. W. HULME,
Editor of "The Subject Index to Periodicals."

Gorseland, North Road, Aberystwyth,
February 23.

Time Relations in a Dream.

I HAVE read with much interest Dr. Atkin's letter in NATURE of January 27, and also Mr. Barcroft's letter in the issue of October 23, 1919 (vol. 104, p. 154) to which he refers. My own observations, made in various degrees of semi-consciousness, appear to show that there is no such thing as a definite time relation, as it depends entirely on the degree of consciousness, the time scale being enormously shortened in the semi-conscious state most remote from wakefulness, so that the images produced by the mind must succeed one another with extraordinary rapidity when in that state. As wakefulness increases, the time scale seems to expand, and the succession of events proceeds more and more slowly, until it practically stops or becomes normal as wakefulness resumes absolute control. I have been led to believe that the mind is *always* active—just like the heart always pulsates—whether we are asleep or awake, and that control and memory are the features of our waking condition, so that we do not remember the images it calls forth, except when we are beginning to awaken, and the degree of activity of our memory in our dreams and the extent of the dream memorised merely depend on the rapidity with which we reach wakefulness.

I have made a number of observations of hypnopompic pictures, or optical illusions, which occur while sinking into slumber or during gradual awakening. I described my first observations in the Journal of the Society for Psychical Research for April 22, 1921, but since then I made several curious observations, some of which concern the case in point.

The hypnopompic pictures which I have observed are generally landscapes passing *slowly* before one's closed eyes, when in an *almost awake* condition, one being fully aware of one's wakefulness, and having one's full reasoning powers *while the illusion proceeds*, so that one can make precise observations and experiments as to the effect of volition, etc. The pictures, which are extraordinarily sharp and full of detail, appear as an endless panoramic band or film passing *slowly* before one's mind's eye, so to speak. The film may pass in any direction, right to left, or the reverse, or vertically downwards, or obliquely. A film may snap, but it invariably slows down as consciousness increases, till it becomes motionless and *then* gradually fades.

It seems as if several such bands or films could exist at the same time, passing one in front of the other, and sometimes in different directions, the uppermost alone being visible of course, and its sudden ending by snapping allowing the one underneath to be visible. This would explain the sudden changes which are often noticed in dreams. The fact that the film is panoramic (and not cinematographic, that is, without perception of translation) is remarkable, as one would have expected it to be cinematographic in character. Once, attaining consciousness very rapidly, I glimpsed, for a couple of seconds, a blurred mass of lines such as one sees from an express train on a wall quite close to the track lines caused by the persistence of vision of the details on the wall, combined with their motion relatively to the train. I have no doubt whatever that I had witnessed the hypnopompic "film" nearly at its normal speed, but with a mind already "slowed down" by the return to consciousness, and unable to cope with its speed and see the details which otherwise I am persuaded—by the agreement of all my observations—would have been visible.

The latter observation bears directly on the question of duration. At such a high translation speed, hundreds of times faster than the usual speeds I had hitherto observed, a whole panoramic view must pass in an extraordinarily short time. Moreover, at such a speed, cinematographic effects are possible, but I fail altogether to imagine by what mechanism they could take place, and so far my observations have given me no clue, although I have once or twice witnessed variations in the process which prevent me from despairing of getting further insight into this mysterious working of our minds. It seems as if control and memory slowed down the working of the mind so that the speed of succession of the images is an inverse function of the degree of wakefulness. M. GHEURY DE BRAY.

40 Westmount Road, Eltham, S.E.9,
February 10.

The Social Influence of Science.

IN his article in NATURE of February 17, p. 209, Mr. F. S. Marvin says: "When in the sixteenth century the mind of Ancient Greece awoke again . . ." The advent of modern science is here considered as a revival and continuation of Greek knowledge; an opinion very commonly held, but entailing some difficulty—a millenary period of stagnation and even retrogression. This is inconceivable; the very essence of science is progress, continuous but not steady, because the rate is increasing. This characteristic of science was pointed out in the Harveian Oration for 1897 by Sir William Roberts ("Science and Modern Civilisation," NATURE, October 28, 1897, vol. 56, p. 621).

Antiquity has been artistic, literary, philosophical with deductive reasoning; but is markedly deficient in the objective study of Nature and the inductive mentality. The philosophers' knowledge of things was part of their system, based on *a priori* principles. Their opinions were many and conflicting, with various degrees of credulity, a few of them by chance right. The influence, if any, on the birth and growth of modern science has been very limited; the method of working, by patient observation and experimenting, is exactly the reverse. The rise of the experimental inductive method was like a botanical mutation and inaugurated a new era in the evolution of mankind. AD. K.

Antwerp, February 17.

It is true that progress was made in certain directions during the "millenary period of stagnation," for example, the improvements in mathematics due to the Arabs. Yet the main fact in the re-birth of science in the sixteenth century is the discovery of the work of the Greeks, especially in geometry, astronomy, and geography. Descartes goes back to Pappus, Copernicus to Aristarchus, Toscanelli to Ptolemy. There is no question that in the general spirit with which the medieval mind regarded Nature there was retrogression, and that the Greek mind did come to life again at the Renascence, partly in its broader quality of rational inquiry, partly in the actual works of Greek thinkers.

F. S. MARVIN.

German Book Prices.

IN reference to Prof. Browning's letter in NATURE of December 23 (vol. 110, p. 845), I should like to point out an added difficulty in India and Burma. Not only are exorbitant prices charged for German books, but to the majority of our students such books are useless owing to their ignorance of the language. The Indian or Burmese student already has to learn English in order to study chemistry, and to ask him to learn German as well is too great a handicap and should be unnecessary.

The appearance of certain recent works on inorganic chemistry shows that British chemists are capable of compiling exhaustive treatises, and a dictionary of organic chemistry in English would be invaluable. The Society of Dyers and Colourists is preparing a colour index, and the combined strength of the Chemical Society and Institute of Chemistry should be able to produce a work on organic chemistry which would enable Indian or Burmese students to carry out research in organic chemistry without constant reference to German works.

D. H. PEACOCK.

University College, Rangoon,
February 2.

Single Crystals of Aluminium and other Metals.

THE brilliant account given by Mr. G. I. Taylor at the Royal Society (February 22) of the deformation of single crystals of aluminium leads me to direct attention to work done in this laboratory ten years ago by Mr. B. B. Baker and Dr. E. N. da C. Andrade. Mr. Baker showed that sodium and also potassium cylinders when stretched contracted laterally so as to lead to an approximately elliptical section, and when they broke they did so at a chisel edge. The surfaces are marked with a double set of slip lines. A photograph of the appearance is shown in the Proceedings of the Physical Society of London for 1913.

Dr. Andrade, who was experimenting at the same time on the traction of metals, showed that similar results were obtainable with tin and lead, and also with frozen mercury (*Phil. Mag.* 1914). He concludes that they are due to large uniform crystals of a size comparable with the diameter of the rod. From the regularity of behaviour over a length of several centimetres it may be concluded that both were dealing with single crystals several centimetres long in the case of each of these materials—at any rate in the same sense as that in which the crystals of aluminium are spoken of as being single.

The crystals of sodium are still in my possession, having been carefully preserved in anhydrous paraffin. They show the characteristics, even the fine surface markings, practically as well as when they were drawn.

ALFRED W. PORTER.

Physical Laboratory, University College,
London, February 26.

Paradoxical Rainfall Data.

AT Blue Hill careful measurements of rainfall have been made for thirty-seven years. There is no break in the record and the amounts are checked by more than one gauge. Data for the entire period 1886–1922 are given in Blue Hill Meteorological Observations. The average monthly values are :

January	101·1 mm.	July	104·1 mm.
February	101·0 ,,	August	100·8 ,,
March	109·2 ,,	September	103·1 ,,
April	94·1 ,,	October	96·4 ,,
May	94·0 ,,	November	97·7 ,,
June	86·3 ,,	December	97·9 ,,

Year . . . . . 1185·7 mm.
Month . . . . 98·8 mm.

The driest month is June and the wettest is March. Yet the driest month in the whole period was March 1915, when the total rainfall was only 1 mm. What is equally remarkable, the wettest month was June 1922, when 274 mm. fell. It is difficult to explain these rainfalls on any theory of probability. The June rainfall was not due to abnormally heavy showers.

ALEXANDER M'ADIE.

Harvard University,
Blue Hill Observatory,
Readville, Mass., February 19.

Atmospherics.

MANY who have "listened in" must have been much interested by the peculiar sounds the telephone generally emits, in addition to those produced by the waves from the broadcasting station. Although atmospherics are produced by the electric discharges during thunderstorms, many would appear to have a very different origin.

In the discussion of a paper on "The Study of Radio-telegraphic Atmospherics in Relation to Meteorology," by C. J. P. Cave and R. A. Watson Watt (Journal of Meteorological Society, January 1923, pp. 35-42), Mr. L. F. Richardson asked Mr. Watson Watt "if he could explain the origin of the peculiar atmospherics which were experienced at Eskdalemuir on the telephone, which was connected with an overhead wire in a lonely valley. In addition to the ordinary clicks there was a 'swishing' sound. The frequency of the vibration diminished as the swish went on. This property was characteristic of the sound of a shell passing high overhead. Mr. Richardson had the idea, perhaps a mad one, that the swish might be produced by a meteorite."

Many of the atmospherics I have heard have had this character, and it may be suggested that the idea that they are produced by very small meteorites is not quite such a mad view as would at first appear.

In the higher atmosphere, there may be a very considerable electric potential gradient, and if a meteorite, entering it, ionised a path in it, an electric discharge might occur along this ionised path sufficiently strong to give off electric waves. There is indeed reason to suppose that the direction from which the waves come is influenced by variations in the sun's position (R. A. Watson Watt, Proc. Roy. Soc., vol. 102, 1923, p. 460).

R. M. DEELEY.

Tintagil, Kew Gardens Road,
Kew, Surrey, February 17.

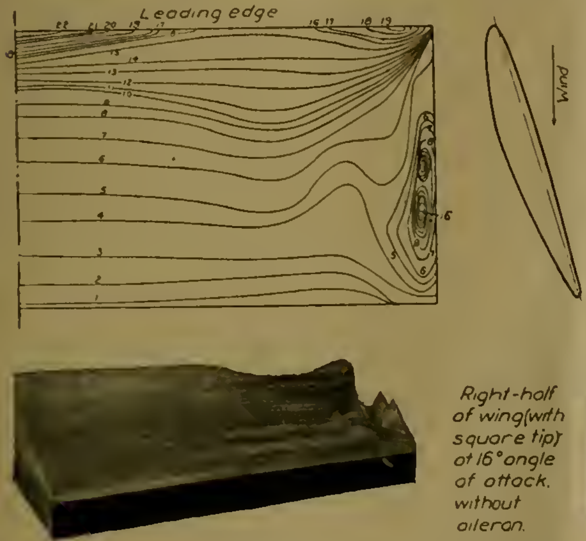
Recent Aeronautic Investigations and the Aeroplane Industry.[1]

By Prof. JOSEPH S. AMES, The Johns Hopkins University, U.S.A.

FEW industries offer better illustrations than the manufacture of aeroplanes of the intimate relation between purely scientific investigations and the practical application of their results. As an example of this fact, attention may be directed to three experimental researches in progress at the laboratories and flying-station of the National Advisory Committee for Aeronautics at Langley Field, Virginia. These researches were begun and are being conducted in order to add to our knowledge of the science of aeronautics, but their results are of the utmost importance to the industry and also to the art of aviation. Other illustrations might well have been selected, but these are, in many respects, of "actual" importance.

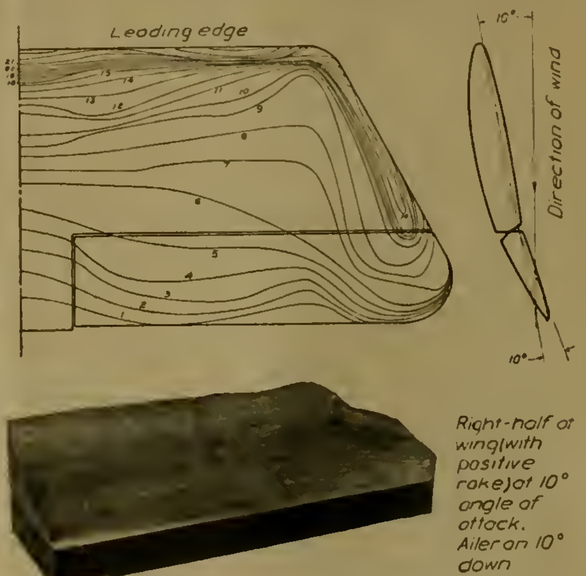
The first research deals with the pressure distribution over the wings, tail-surfaces, etc., of an aeroplane—an old problem, studied with marked success by the staffs of the British establishments at Teddington and Farnborough. What is novel in the present investigation is the extension of the problem to aeroplanes making manœuvres, and to wings of different plan form, varying the angle of attack and the aileron angle. The method adopted is simple: numerous series of small openings are made in the surface to be investigated; each of these is joined by a rubber tube to a capsule containing a metal diaphragm, to which is attached a tilting mirror; a beam of light is reflected from this on to a photographic film which may be shifted, thus permitting a series of observations to be made. The apparatus in use records the pressures existing at sixty points simultaneously. All the diaphragms are, of course, standardised and calibrated. (In the case of wind-tunnel experiments a number of liquid manometers are used.)

Among the questions already investigated are: the change in pressure distribution produced by a loop, a roll, etc.; the effect of the shape of the wing-tip, square corners, elliptical, raked off, etc.; the influence of the air-stream from the propeller. In all cases the pressures are measured quantitatively, and the results are shown in two ways: by making plaster or wooden models, like a relief map; and by drawing contour lines of pressure (Figs. 1 and 2). From the knowledge thus obtained, the aeroplane engineer can decide upon the best shape of wing or elevator, etc., and upon the relative strength required in different parts of his structure; and further, if a breaking sand-load test is thought necessary, he can so distribute the load as to make it correspond to actual flying conditions.



Plan and elevation showing contour lines. and built-up model.

FIG. 1.



Plan and elevation showing contour lines and built-up model.

FIG. 2.

The second research was undertaken to learn the actual motion of an aeroplane in alighting, taking off, making oscillations and manœuvring, and at the same time to record the motions of the control surfaces and the forces exerted by the pilot (Fig. 3). A large number of instruments are required, all of which were newly designed with special reference to lightness and compactness, as well as to accuracy. The central instrument is a photographic film wrapped on a cylinder which is in rotation, for all records are made upon this by beams of light reflected from mirrors which form part of all the various instruments. When in actual use on an aeroplane, the pilot simply presses one button at the beginning of a manœuvre, and this starts everything. The instruments in use at the present time are as follows:

(*a*) Chronometer, consisting of a constant speed

[1] Substance of a lecture delivered before the Franklin Institute, Philadelphia, on November 23, 1922.

motor, properly governed. Lines of light are recorded at definite intervals, *e.g.* two seconds.

(*b*) Air-speed recorder, simply a Pitot-Venturi nozzle attached to suitable pressure-recording capsules.

(*c*) Single component accelerometer, consisting in the main of a damped steel spring, one end of which is free.

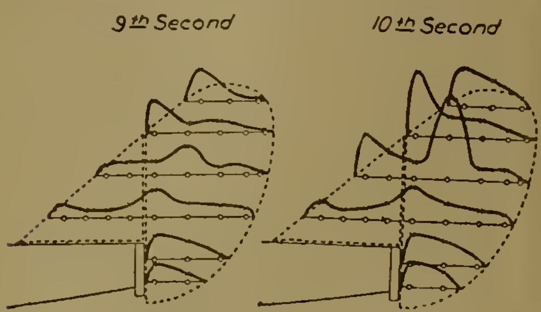


FIG. 3.—Showing the curves of pressure on the entire surface of the rudder at various intervals during a left turn.

(*d*) Three-component accelerometer, a combination of three of the previous instruments. The sensitiveness of the three is adjusted corresponding to the amount of the acceleration to be expected.

(*e*) Angular velocity recorder, making use of a high speed electric motor as a gyroscope. The curves obtained by this give, when integrated, angular displacement, and when differentiated, angular acceleration.

(*f*) Three-component angular velocity recorder, a combination of three of the previous instruments.

(*g*) Control position recorder, consisting essentially of three spring-controlled spools threaded on an axial screw, each spool actuated by a wire leading to the horn of the control surface.

(*h*) Force recorder, using a carbon pile resistance method.

Of course all these instruments are not used at the same time, but only as many as are needed for the study of each particular question.

From a practical point of view these instruments allow the performance of an aeroplane to be recorded accurately, in a manner quite free from the personal impressions of the test-pilot; and, further, the records taken in any manœuvre tell a story which is perfectly plain. Numerous questions, often raised by pilots, have already been answered, and pupil pilots have received great assistance.

The last research to be mentioned is one which is only beginning, but the apparatus has been carefully tested, and a few preliminary readings have been made. This refers to a new method of investigating the "scale effect." In the ordinary wind tunnel the forces and moments on a model of about one-twentieth the full scale are observed, and from these measurements deductions are made as to the promised performance of the full-sized aeroplane, or part thereof. It has been known for many years that in order for these deductions to be justified it would be necessary to have in the tunnel and in the flight of the actual aeroplane the same Reynolds's number, as it is called. This number is the fraction $\rho VL/\mu$, in which ρ is the density of the air, V is the relative velocity of the air-stream, L is a linear dimension of the aeroplane (or part), and μ is the coefficient of viscosity. It is clear that the Reynolds's number in the tunnel is about one-twentieth, or less, that of the aeroplane in flight. To obviate this, a complete wind tunnel has been installed inside an elongated steel tank—35 feet long, 15 feet in diameter—in which the air is kept compressed to 20 or 30 atmospheres (Fig. 4). The walls of the tunnel proper are hollow, and in this space the balances are installed, so as to be out of the air-stream. The attitude of the model in the tunnel may be varied, and the balancing weights may be shifted, etc., by small electric motors, controlled from outside the tank. Readings consist in viewing through suitable small windows a number of Veeder counters. The importance of this apparatus from the point of view of aerodynamics is sufficiently obvious, and from that of the aeroplane designer even more so.

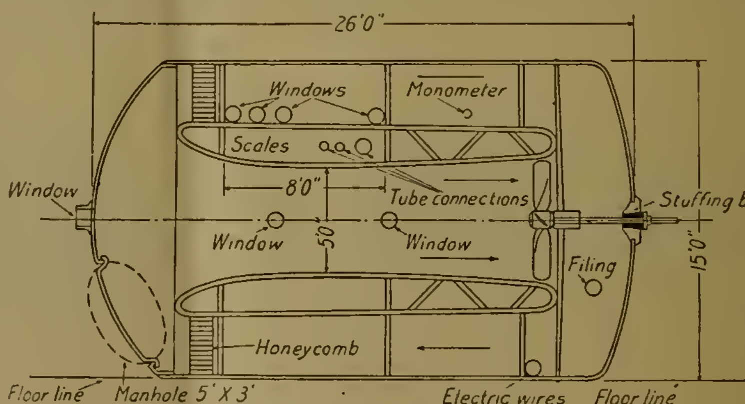


FIG. 4.—Compressed air wind-tunnel.

Radiography and Physics.[1]

By Dr. G. W. C. KAYE.

THE frail, untrustworthy X-ray tube of 1895 and the more robust and dependable tube of the present day do not differ in principle. The X-ray tube still remains a device for generating high-velocity electrons and suddenly depriving them of that velocity by hurtling them against a target. In fact, the tube possesses all the characteristics of a battlefield, except that as yet we lack the ability to give our shells speeds of the order of 50,000 miles a second. Then, just as a flash of flame accompanies the sudden stopping of the shell, so do the X-rays set out in all directions from the target, travelling in straight lines just as

[1] Abstracted from the opening address to the Society of Radiographers, October 31, 1922.

light rays radiate from a lamp. The X-ray tube is, indeed, an X-ray lamp in which the applied voltage is analogous to the temperature of a luminous lamp. If we raise the temperature of the latter, we shorten the average wave-length; so with the X-ray bulb, if we raise the voltage the average wave-length is diminished.

In the light of present-day knowledge, what do we know to be the factors which control output from an X-ray tube? The radiographer is concerned more with the general or continuous spectrum of X-rays than with the superposed rays characteristic of the target. In regard to the former the factors are three: (*a*) The number of the cathode rays or electrons which strike the target; (*b*) the speed of the electrons; (*c*) the massiveness of the atom of the target. (*a*) is represented by the current through the tube, (*b*) by the voltage across the tube, (*c*) by the atomic weight or, more precisely, the atomic number of the metal of the target.

To what extent do these several features come in? To settle these points let us call in the aid of the X-ray spectrometer and vary each of the factors one by one. The spectrometer spreads out into a continuous fan of rays all the various wave-lengths present, and tells us, moreover, the amount or intensity of each wave-length. So that if we plot wave-length against intensity, we get a curve which clearly reveals the composition of the beam. Furthermore, the area of the curve is a measure of the output. If we do this, we find that the several spectral curves show that the X-ray output is proportional to the current, to the atomic number of the target, and to the square of the voltage.

We notice that the voltage comes in as a second-power term, and the importance of measuring voltage by the radiographer not sporadically but as a routine procedure day in and day out should be stressed. For the applied voltage has a dual importance: it not only dominantly affects the output, but it is the sole arbiter of quality or penetrability or wave-length.

The time is approaching when we must gradually relinquish the use of the terms "hard" and "soft" X-rays and accustom ourselves to speak of wave-lengths. For example, in deep therapy we can say that the spectrum of rays employed lies between 0·06 and 0·2 Å.U., the mean effective wave-length being about 0·15 Å.U. or less. The radiographer who uses point spark-gaps up to, say, 6 inches long employs a spectrum of rays ranging from about 0·12 to 0·4 Å.U., the mean effective wave-length generally lying between 0·2 and 0·3 according to the filter and nature of the high potential generator. We might make a beginning by agreeing, for example, that "hard" rays refer to rays with wave-lengths shorter than 0·1 Å.U., and that "soft" rays have wave-lengths longer than 0·3 Å.U., the intervening rays being of "medium" hardness.

Let us consider the career of an electron in an X-ray tube impelled towards the target with a velocity which it owes to the applied voltage V. The chances that that electron will ultimately come into suitable conflict with one or more atoms in the target and so generate X-rays are slight—about 1000 to 1. The energy of the electron is, in fact, much more likely to be frittered away as heat. Assuming that the unlikely happens, one of two things may occur: the electron may lose all its energy at one encounter or it may do so by instalments in a succession of encounters. In other words, if we agree to think of its energy in terms of the original driving voltage (V), then it may lose the whole of V in one step or do so in a number of steps.

Now Planck's quantum relation tells us that whenever an electron has its speed altered the wave-length of the X-ray produced is inversely proportional to the energy given up by the electron; that is, to the equivalent loss of propelling voltage. It will be noted that no question arises of the nature of the target. To put it another way:

$$\left(\begin{array}{c}\text{Loss of propelling}\\ \text{voltage on electron}\end{array}\right) \times \left(\begin{array}{c}\text{Wave-length of}\\ \text{resulting X-ray}\end{array}\right) = \text{const.}$$

In those encounters where the whole of the energy of the electron is transferred in one fell swoop, the shortest-waved X-rays possible to that voltage will be generated. They will be accompanied by a variety of longer waves depending on the varied experience of other electrons, but always a short-waved limit is set by the magnitude of the full exciting voltage.

We are led to appreciate a number of other results. It is seen at once why we do not get (as was once imagined) homogeneous X-rays when a tube is excited by constant potential, and where all the electrons reach the target with the same velocity. Nevertheless, we should expect that the proportion of short waves would be greater with constant potential than it would be with fluctuating potential, the peak value of which is equal to that of the constant potential. Furthermore, from what is known of the effect of voltage on output, we should anticipate a greater X-ray output (and less heating of the target) with a constant voltage than when that voltage is diluted with lower voltages. Both these surmises as to the superior efficacy of constant potential are confirmed by the X-ray spectrometer.

With reference to the existence of a minimum wave-length or boundary to every spectrum of general X-rays, this is fully borne out by spectrometer measurements and photographs. Numerically, Planck's relation becomes:

$$\left(\begin{array}{c}\text{Minimum wave-}\\ \text{length in Å.U.}\end{array}\right) \times \left(\begin{array}{c}\text{Maximum}\\ \text{voltage}\end{array}\right) = 12{,}350.$$

This very simple relation provides us with a scale of quality which, if not perfect, is more exact than any which the radiologist has been in the habit of using. If we glance at typical spectral curves of X-ray emission, we see that they are not symmetrical—the centre of gravity of the curve is well towards the quantum limit—the shortest waves are the dominating ones, and still more so if the rays are subjected to normal type filtering. The mean effective wave-length of a spectrum of rays is seen to approximate to the wave-length of the peak of the curve; that is, the wave-length of maximum intensity. Now, there is some evidence that the "peak" wave-length is proportional to the limiting or quantum wave-length, and this fact enables us so to identify very fairly the quality of a mixed bundle of X-rays. No doubt something depends on the wave-form of the exciting potential, but the effect of this is probably less important as the voltage is raised. The precision of the method would be enhanced if steps were taken to standardise apparatus and technique, so that all work could be done by the use of, say, three or four spectra the distinctive features of which, including energy distribution, could be determined and specified.

Among the other interesting aspects of the X-ray tube is the distribution of the rays in different directions from the target. With the usual 45° target the rays are most intense at right angles to the cathode ray beam. For radiographical purposes it is often better to mount the target face more nearly at right angles to the cathode beam and thus employ a pencil of rays which leaves the target face at a relatively small angle. The width of the focal spot is thus foreshortened and definition enhanced.

If penetrating power is the important factor, then we may well endeavour to utilise the X-rays leaving the tube in the direction of the cathode rays, which X-rays are of appreciably shorter wave-length than in other directions. Thus a tube in which the target also served as a metal window would offer advantages on this score.

The proper choice of filter may do much to increase the effectiveness of a tube. For example, it is known that, weight for weight, silver is relatively more transparent than lead to short waves, but is relatively less transparent to longer waves. Again, copper is relatively superior to aluminium in letting through short waves, but relatively inferior as a filter if long waves are required.

What has the future in store for us as regards X-ray tubes? Higher voltages are coming—one hears rumours of 500,000 volt tubes in Germany; and both the United States and Germany have, I understand, developed transformers giving 1 million volts. The life of 200,000 volt tubes is none too long; there will be many difficulties to overcome before a 500,000 volt tube will become a practical proposition.

A crying need is more robustness in the X-ray tube, which must become more of an engineering job. The portable Coolidge tube with lead-glass walls ¼ inch thick and a window of soda-glass for letting out the rays is to be commended on this score. Equally robust is the new miniature dental tube of similar design which measures only 4 to 5 inches long and has a diameter of about 1½ inch. It is operated at 45,000 volts and 10 milliamperes, is mounted in the same oil-tank as the transformer, and gives excellent definition. It also contributes substantially to the protection which the radiographer has a right to demand. In this connexion we may confidently look forward to a time at no very distant date when, in the interests of the operator, all protective material and apparatus shall be certified by the National Physical Laboratory. This will be realised when I mention that different makes of lead-glass on the market differ by 100 per cent. in protective value. The same remark applies to lead-rubber.

What should be our ideal in radiography? To make the process as simple and noiseless as taking an ordinary photograph. The patient should hear nothing untoward, the apparatus should look no more formidable than a camera. Spark and brush discharges should be taboo; the rumble of rotating machinery anathema. Standardised technique must be the order of the day for much of the radiographer's work. The number of variables must be cut down.

It is possible that the future may witness the fuller development of the metal X-ray bulb of a design radically different from the present. Much work is being done on them at the present time. But in almost every section of a radiographer's X-ray equipment there is room for great improvement. How low the efficiency is may be gathered from the following. We may take it that the efficiency of the high-tension generator is of the order of 50 per cent., that of the X-ray bulb 1/1000. We may assume that half the rays emitted by the bulb are utilised, that half these useful rays are arrested by the object, and that 1 per cent. of the remainder is recorded by the photographic plate or screen (rather more, say 5 per cent., if an intensifying screen is used). Thus the overall efficiency of an X-ray equipment is of the order of 1 in 800,000.

An Inquiry into Dog Distemper.

FOR some considerable time it has been felt in this country that an investigation might be undertaken with advantage on the mystery of dog distemper, and the matter has recently been brought to a head by an appeal from the editor of the *Field* to dog lovers. A considerable sum of money has been promised, and the Medical Research Council has undertaken to organise an experimental inquiry with a view of finding out the causal agent of the disease and possibly a prophylactic. As announced in NATURE of March 10, a committee has been appointed under the chairmanship of Sir William Leishman, the other members being J. B. Buxton, S. R. Douglas, F. Hobday, and C. J. Martin. Other workers, it is suggested, will be co-opted for special investigations later on.

Distemper is an acute highly contagious disease, presenting symptoms somewhat analogous to measles in man. While some have regarded it as specific for the dog, others consider that it occurs in cats, young foxes, wolves, jackals, hyænas, and even monkeys. From its contagiosity it is certain that the cause is a microbe of some kind, which, however, has hitherto remained unmasked. Indeed, there is very little real scientific knowledge extant on the disease. This is in part, at any rate, due to the fact that what veterinary surgeons and the laity call distemper is almost certainly not one but several different diseases. That one of these is the specific disease distemper is, however, very probable.

At present the concept of "distemper" is entirely clinical. Thus, one finds descriptions in the literature of catarrhal, gastric, nervous, and exanthematic types of the disease. There is a great body of evidence to show that one attack of the malady confers a durable immunity on the survivor. The disease occurs in all countries and was apparently known in antiquity. On the other hand, there is a tradition—it is little more—

that distemper was introduced into Europe from South America in the seventeenth century. There have been many researches on the probable cause, and from the time of Semmer (1875) down to the present, every known type of microbe has been incriminated, many authors with great assertiveness having maintained that they had found the specific micro-organism.

Many have believed that Carré came nearest the truth with the idea that the *causa morbi* is an invisible microbe which can traverse bacterial filters. With filtrates obtained from nasal secretions he obtained lethal effects which were claimed to be identical with true distemper, and he regarded the visible bacteria found by others as of the nature of secondary invaders, which obtained a hold on the tissues as a result of the depressing effect of the real filter-passing virus.

This view is largely accepted without criticism, and is said to be the line along which the new committee will work. It may be pointed out, however, that Carré's work, which is not given in any great detail, has been adversely criticised by Galli-Valerio, and especially by Kreganow, who worked under the direction of Frosch, himself a known and successful worker on the filter-passer of foot-and-mouth disease. Filter-passers have been suggested or proved for a number of pathological conditions, notably the mosaic disease of tobacco plants, foot-and-mouth disease, Cape horse sickness, fowl plague, molluscum contagiosum, etc. These filter-passers have much in common. They are highly infectious, invisible, filterable, and non-cultivable. The causes probably constitute a new group of living things, which, if discovered in the case of distemper, may throw a flood of light on many unknown causes of disease in man, and it is for this reason that the work now being undertaken on distemper will be watched with unusual interest.

W. B.

Obituary.

Prof. E. E. Barnard.

It may safely be said that the whole astronomical world is mourning the death of Edward Emerson Barnard, which occurred on February 6, and very many will feel it as the loss of a personal friend even more acutely than as the removal of one of the world's most remarkable observers.

Prof. Barnard was born at Nashville, Tennessee, on December 16, 1857; he was left fatherless and destitute by the Civil War, and had to go out to work in a photographic studio in Nashville at the age of nine, after the most meagre opportunities of education. But his subsequent career is a remarkable proof of the adage that "where there is a will there is a way." He worked most faithfully for his employers, and at the same time devoted his evenings to private study; it was not till the age of nineteen that his attention was directed to astronomy by perusal of Dr. Dick's "Practical Astronomer." The next year he had saved enough to buy a 5-inch telescope, with which in 1881 and 1882 he discovered the first two of his large family of Comets.

In 1883 Prof. Barnard obtained a fellowship in astronomy at Vanderbilt University, which gave him the opportunity for perfecting his education and the use of a 6-inch equatorial, with which he did useful work on comets, nebulæ, and double stars.

In 1888 Prof. Barnard went to the Lick Observatory, where he had the advantages of a giant telescope and a splendid climate. Three years later he made the sensational discovery of the fifth satellite of Jupiter, the first addition to the retinue of that satellite since the days of Galileo. In 1889 he had observed an eclipse of Japetus by Saturn and the ring which gave important information on the transparency of different parts of the crêpe ring. He was also doing very useful photographic work, photographing the Galaxy and the tails of comets with the Willard lens. These photographs showed interesting detail, in particular the shattered tail of Brooks's Comet of 1893. He demonstrated the value of a lantern lens for depicting faint diffused nebulosity; in particular, he discovered a huge nebula with many wisps that wandered over the greater part of Orion, the former "great nebula" of which was but a pigmy compared with it. Besides discovering very many new comets, he was frequently first in the field in detecting periodic ones on their return: for example, Pons-Winnecke in April 1921, the position of which had only been roughly predicted. In 1896 he left the Lick Observatory for the Yerkes Observatory, but the change involved no real break in his work.

Prof. Barnard took up a new and fruitful line of work in recent years, making a minute study of the light changes of all the Novæ that have appeared in modern times. Many of them had become excessively faint and difficult objects, but he was able to prove that some of them were still varying in a more or less regular manner.

Mention should also be made of Barnard's discovery of the star of largest known proper motion; this was no mere accident, but a well-earned fruit of careful study of numerous photographs.

Prof. Barnard was both a fellow and an associate of the Royal Astronomical Society, and was awarded its gold medal in February 1897.

It is pleasant to record that Prof. M. Wolf named two of his minor planet discoveries Barnardiana and Rhoda after Barnard and his late wife. It is a testimony to the universal sentiments of affection and esteem that were felt towards them.

A. C. D. Crommelin.

Prof. J. Radcliffe.

Prof. Joseph Radcliffe, head of the department of Municipal and Sanitary Engineering in the Municipal College of Technology, Manchester, died on February 16 at his residence in Crumpsall after a brief illness, at the age of sixty-six years.

A native of Rochdale, Prof. Radcliffe was forced by circumstances to commence to earn his own living at a very early age, but managed to attend evening classes with such success that he was one of the first scholarship students sent by the Rochdale Pioneers' Co-operative Society to the then Owens College at Manchester. After serving an engineering apprenticeship in Rochdale, he passed into the Waterworks department, where he gained a special experience, which led to his later appointment as engineer to the Todmorden waterworks. In 1891 he commenced his career as professor in the Manchester College of Technology, where he had previously devoted untiring energies to founding the department by holding evening classes. In 1906, the Victoria University of Manchester conferred on him the degree of M.Sc.Tech.; and practically all the institutions and societies interested in his subjects had recognised his great abilities.

It is no exaggeration to say that the death of Prof. Radcliffe will be sincerely mourned all over the globe by former students, the numbers of which must literally run into thousands. Apart from his sound teaching, his wonderful kindness and modest, genial disposition have made his one of the most regretted losses his college and profession have ever sustained.

MR. T. W. STRATFORD-ANDREWS.

MR. T. W. STRATFORD-ANDREWS, who died on February 17, was a director of many companies connected with electrical industries. He was born in 1870 and educated at King's College, London, and his practical training in engineering was obtained at the works of Siemens, Schuckert, in Berlin.

Mr. Stratford-Andrews succeeded his father as managing director of the Indo-European telegraph line in 1899, but before assuming his new duties he took part in the expedition which went 800 miles up the river Amazon to lay an extension of the Western Brazilian telegraph cable. In 1897 also he rode on horseback through Russia and across the Caucasus to Teheran to inspect the route of the Indo-European land line. This journey he described in a little book entitled "Overland to Persia." In 1913 he covered the same ground again in a motor car accompanied by his wife and his sister. He was decorated by the Shah of Persia for his services, and received the thanks of the Russian Government.

Mr. Stratford-Andrews was the first to introduce direct automatic Wheatstone working on the Indo-European system. He also initiated, in conjunction with Sir Henry Kirk of the Indo-European (Government) department, direct operation at high speed between London and Karachi, a distance of 5600 miles. In his later years he took the greatest interest in radio-telegraphy and telephony, and he was chairman of the Radio Communication Company. His wide knowledge and technical insight were much appreciated by his numerous colleagues.

PROF. IGNAZ VOGEL.

THE death occurred on December 29 last of Prof. Ignaz Vogel, a well-known agricultural bacteriologist and mineralogist. He was born on April 15, 1871, at Altenkunnstadt in Franconia, and after studying chemistry under Emil Fischer at Würzburg he graduated in 1893. Taking up physiological and bacteriological research work, he became assistant to Prof. Dunbar at Hamburg, where he remained till 1900. He was then appointed to the position of bacteriologist at the agricultural experimental station of Posen, being transferred five years later to the Emperor William Institute at Bromberg. In 1914 he was called to Leipzig as director of the bacteriological department of the Agricultural Institute of the University of Leipzig, where he succeeded Prof. Löhnis, who had received an appointment as agricultural expert in the United States.

Prof. Vogel published at Marburg a number of researches on the occurrence and the transformation of the various kinds of sugar in the bodies of plants and animals, most of which appeared in the *Zeitschrift für Biologie*. Later he turned his attention to the study of the bacteria of the soil, and of solid and liquid manure. He published numerous papers concerning the fixation of atmospheric nitrogen in the form of ammonia, and the transformation of this substance into nitrates and albumen, most of which appeared in the *Zentralblatt für Bakteriologie*. In the "Handbuch der Milchwirtschaft" he edited the agricultural section.

The researches of Vogel have contributed greatly to the increase of agricultural production by showing how the various methods of manuring can be properly adjusted to the qualities of the soil. In his university work he trained a number of able pupils, being always willing to communicate his great knowledge to his colleagues. All those who have been able to enjoy his teaching and society greatly regret the loss that agricultural science has suffered through his premature decease.

PROF. A. N. FAVARO.

ON September 30 of last year, there passed away at Padua, Antonio Nobile Favaro, widely known for his numerous contributions to the history of mathematics and physics. Born at Padua on May 21, 1847, educated at the University of Padua and at the engineering schools at Turin and Zurich, he entered in 1875 upon his long career as professor of projective geometry at Padua. His "Lezioni di statica grafica" (1877) were soon after translated into French. So early as 1873 he began the study of the history of science by a contribution on the evolution of planimeters. For nearly half a century he worked assiduously on questions dealing with the history of mathematical instruments, with papers and letters of Tycho Brahe, N. Tartaglia, Leonardo da Vinci, and others.

The researches for which Favaro is best known, and which mark the crowning effort of his long career, are on the life and work of Galileo and his friends. In 1887, Favaro received a commission from the Italian Government to edit the complete works of Galileo. He devoted nearly thirty years to this task and brought out the "Edizione Nazionale" of Galileo's works in twenty volumes, which serves as a model to other governments as to what can and should be done in editing the works of great men of science. As by-products Favaro brought out a series of publications, "Amici e corrispondenti di Galileo Galilei," consisting of more than forty parts and constituting an important contribution to our knowledge of science in Italy during the sixteenth and seventeenth centuries.

FLORIAN CAJORI.

WE regret to announce the following deaths:

Dr. Norman Dalton, senior physician to King's College Hospital and formerly professor of pathological anatomy in King's College, London, on March 9, aged sixty-five.

Prof. J. D. Van der Waals, professor of theoretical physics in the University of Amsterdam, on March 8, aged eighty-five.

Current Topics and Events.

It is fitting that some reference should be made in these columns to the fact that it was just fifty years ago that Mr. Edward Clodd, the veteran scientific thinker, happily still with us, published his first book, "The Childhood of the World." In 1920, at the advanced age of eighty, he published his "Magic in Names." In the period which elapsed between the appearance of these two books, Mr. Clodd devoted the leisure of a busy life of affairs to scientific research in branches of study connected with the physical and mental evolution of man. The results were embodied in a number of volumes dealing with various aspects of this central problem, of which the principal are: "The Childhood of Religion," 1875; "Myths and Dreams," 1885; "The Story of Creation," 1888; "The Story of Primitive Man," 1895; "A Primer of Evolution," 1895; "Tom Tit Tot," 1898, perhaps his best known and most enduring work; "The Story of the Alphabet," 1900; and "Animism," in 1906. In addition he produced monographs on his friends and associates—Bates, of Amazon fame, Grant Allen (1900), Huxley (1902), and a volume of "Memories" published in 1916. Mr. Clodd was one of a band of workers, of whom Huxley and Tylor were the best known, and who now, unfortunately, have nearly all passed away. To their untiring efforts to promote and popularise anthropology, its present position as a serious branch of scientific study is almost entirely due. Those of a younger generation who were first introduced to the evolutionary point of view in the study of man and of his religion and mental concepts through the lucid exposition and power of logical demonstration of which Mr. Clodd is a master, owe to him a debt of gratitude which is not likely to be forgotten.

Further details of the progress of excavations at the Temple of the Moon God at Ur of the Chaldees, to which reference was made in these columns last week (see p. 336), are now to hand. Information given in a telegram published in the *Times* of March 7 indicates the relation of the present discoveries to those made by Dr. Hall in the course of his investigations—a point which previously was not clear. It would appear that the portion of the Temple discovered by Dr. Hall was the terrace of the main building which lay underneath. In the course of the present excavations, which have been made mainly in the south-east corner of the mound, one chamber has been found, which it is conjectured may be the innermost shrine, containing a valuable hoard of jewelry including many bracelets and necklaces, mostly of gold, and a tiled courtyard in which a gutter, such as was habitually used for collecting and carrying off the blood of a victim, suggests that it was the place of sacrifice. The cult of the Moon God was evidently re-established by Nebuchadnezzar, who made his daughters priestesses of the Temple, which he restored in the sixth century B.C., as is shown by an inscription. The upper bricks of the ruins were of this period, but those underneath were much earlier, and it is clear that in the restoration of the Temple the original foundations were, so far as possible, left untouched.

Dr. Charles Hose's lecture on Sarawak at the Royal Colonial Institute on February 27 was opportune in affording material for a comparison in methods of administration and development with British North Borneo, an area which has attracted some little attention recently. Sarawak, a territory of some sixty thousand square miles, is perhaps best known in connexion with the romantic history of the Brooke family and as an independent native state under British protection, which has been ruled for nearly a century by a family of white men. It is, as Dr. Hose said, "perhaps the greatest achievement in state-making of the nineteenth century." It was founded by Sir James Brooke in 1840, and came under British protection in 1888 when its population numbered 600,000. The inhabitants include Malays, Dayaks, Kenyahs, Kayans, and a number of primitive tribes, still pagan, whose customs and beliefs have furnished, as readers of that valuable book "Pagan Tribes of Borneo," by Dr. Hose and Prof. McDougall, will remember, much material for the comparative study of religion, especially in connexion with their methods of divination and their belief in a spirit helper in animal form. The policy of the Brooke family has been to preserve, under an autocracy, as much of native custom as possible, retaining the great offices of state held by Malay nobles at the time of Sir James Brooke's accession to power, and associating the natives with the administration. As Dr. Hose pointed out in his lecture, several chiefs in bygone days endeavoured to establish peace through wide areas, but failed. To achieve enduring success the unifying influence of a central authority was needed. This has been furnished by the Rajahs, who, without breaking up old forms of society, have supplied elements lacking in the old system.

Information has been received that an All Russian Agricultural Exhibition will be held in Moscow on August 15–October 1. In a circular issued by the Russian Trade Delegation it is stated that foreign firms, institutions, and private persons are invited to participate in the exhibition, and that all privileges granted to Russian exhibitors will apply equally to foreign exhibitors. Special arrangements will be made to facilitate the delivery of exhibits, all such goods being given preferential treatment on the railways and waterways of the Republic, and for convenience of transit all foreign exhibits will be exempt from Customs examination at the frontier, provided that the goods bear regulation labels. Provision will be made for the insurance and safeguarding of exhibits, both during transit and at the exhibition itself. A fixed tariff of charges for space in the foreign section has been drawn up, all charges being payable in advance and not to be refunded if exhibitors renounce their allotted space or finally abstain from exhibiting.

The Council of the Institution of Mining and Metallurgy has made the following awards: The gold medal of the Institution to Mr. Edgar Taylor, president, 1909–1911 and 1916–1918, in recognition of his services to the Institution since its foundation in 1892 and as an evidence of appreciation of his honourable record of work in connexion with the development of the mining industry, particularly in India; "The Consolidated Gold Fields of South Africa, Ltd." gold medal to Dr. Leonard Hill, in recognition of his valuable researches on ventilation and for his paper on "Ventilation and Human Efficiency," contributed to the Transactions; and "The Consolidated Gold Fields of South Africa, Ltd." premium of forty guineas to Mr. H. F. Collins, for his paper on "The Igneous Rocks of the Province of Huelva and the Genesis of the Pyritic Ore-bodies," contributed to the Transactions, and in recognition of his researches on the subject.

An invitation is extended to Farmers' Clubs, Chambers of Agriculture and Horticulture, and other bodies interested in agriculture or market-gardening, to visit the Rothamsted experimental fields during the coming summer. The guide demonstrator is Mr. H. V. Garner, who for the past two summers has very successfully served in this capacity and has been able to make the visits both useful and interesting to farmers. Among important items of interest are: experiments on the manuring of arable crops, especially wheat, barley, mangolds, potatoes; manuring of meadow hay; effect of modern slags and mineral phosphates on grazing land, hay land, and arable crops; crop diseases and pests; demonstrations of good types of tillage implements, tractors, etc. At any convenient time between May 1 and October 1, there is sufficient to occupy a full day, and there is provision for assuring that the time shall not be lost, even if the weather turns out too bad to allow of close investigation of the fields. The director of the Station, Sir John Russell, will be happy to arrange full details with organisations of farmers, farm-workers, and others wishing to accept this invitation. Small groups of farmers are specially welcomed; if possible, arrangements should be made beforehand, but it is recognised that farmers' movements must often depend on the weather, and no one need stay away because he has been unable to write fixing a date.

The departmental committee recently appointed to consider the present system of charging for coal gas on a thermal basis has now issued its report as a White Paper (Cmd. 1825, 6*d*.). The main recommendation is that the method of charging for gas on the thermal basis should be continued and extended to all statutory gas undertakings within the scope of the Gas Regulation Act. Thus is vindicated the really scientific method of asking the consumer to pay according to the amount of heat he receives. In the days of Argand and the flat-flamed fish-tail burners, light was produced by the combustion of the particles of gas in the surrounding air, and gas supply was then maintained at an illuminating standard. With the advent of the incandescent mantle, and the increasing use of gas fires, illuminatory properties in gas became of secondary importance to its heating values, and a calorific standard was introduced in 1916. The heat unit in common use in Great Britain for expressing the value of fuels has been, for many years, the British thermal unit, which is the amount of heat required to raise the temperature of 1 lb. of water 1° F. under appropriate conditions. This unit was used in gas calorimetry, and a gas was said to have calorific value of 500 British thermal units when 1 cubic foot gave out, when burned, sufficient heat to raise the temperature of 500 lb. (about 50 gallons) of water through 1° F. To obtain a conveniently practical unit, the therm, which is equal to 100,000 British thermal units, was adopted.

The *Weekly Weather Report* for the week ending March 3, issued by the Meteorological Office, Air Ministry, gives a summary of the weather for the several districts of Great Britain for the past winter, comprised by the thirteen weeks from December 3, 1922, to March 3, 1923. The daily mean temperature for the period ranged from 40·1° F. in the east of Scotland to 46·9° F. in the Channel Islands. During the winter the extreme readings ranged from 61° in the Midland Counties to 15° in the east of Scotland, while in England the lowest temperature recorded was 22° in the Midland Counties and the south-east of England. Total rainfall was greatest in the north of Scotland, where the measurement was 18·52 in., which is 2·17 in. more than the normal; but the greatest excess on the average was 5·47 in., which occurred in the south-west of England. There was an excess of rain everywhere, the minimum excess being an inch in the east of England, where the total measurement was 6·53 in. Rain fell with greater frequency than the normal over the whole of Great Britain: the largest number of days with rain was 74 in the north of Scotland; the least, 53 in the north-east of England. The duration of sunshine was fairly equal to the normal in all districts. At Greenwich the mean temperature for the winter, December, January, and February, was 42·4° F., which is 2·9° above the normal for thirty-five years; temperature ranged from 57° to 24°. Rain fell on 49 days, which is 4 days in excess of the normal, and the total measurement was 6·60 in., which is 1·08 in. more than the average for thirty-five years. The duration of bright sunshine at Greenwich was 118 hours, which is 11 hours fewer than the normal.

News received in Christiania, according to the *Times*, reports the arrival of Capt. R. Amundsen on December 15 at Nome, Alaska, from Wainwright, on the north coast, where he is wintering. His visit to Nome was to ascertain news of the *Maud*, which is now drifting across the polar basin. Capt. Amundsen expects to leave Wainwright or Point Barrow on his flight across the Pole to Spitsbergen in the middle of June. On March 6 a wireless message from the *Maud* reported her position as lat. 74° N., long. 170° 30′ E. The ship has drifted about half a degree north and three degrees west of her position in the middle of December. Her speed of drift is about the same as that of the *Fram* at the same time of year, but the *Maud* is still well to the east of the New Siberia Islands and has not passed beyond the shallow and partially charted waters of the continental shelf.

H.M. THE KING has approved the grant of a Royal Charter of Incorporation to the Institution of Royal Engineers. The Institution, then known as the Royal Engineers Institute, was established as a voluntary association in the year 1875 for the general advancement of military science, and more particularly for promoting the study of such subjects as are of importance to the military engineer. In pursuance of its objects, the Institution has directed its efforts to the advancement of the science and art of engineering, especially in relation to their application to military purposes, and has thus been able to afford material assistance to those engaged in dealing with the important problems of defence connected with the British Empire. The Institution has during the past 47 years published 950 occasional, as well as other, papers on military and other scientific subjects; these papers, except those which are of a "Secret" or "Confidential" character, are available to the general public. *Inter alia*, the Institution now administers an important fund established in connexion with the award of scholarships to the children of deceased officers and other ranks who have fallen in the performance of their duties while on active service.

IN an article in the *Fortnightly Review* for March, Sir Charles Bright discusses the relation between the Empire's telegraphs and trade. He concludes that it is of national importance that there should be a great all-round reduction in cable tariffs. As this would doubtless result in greatly increased traffic it would necessitate laying many additional cables on different routes. He also dwells on the importance of the immediate completion of the Imperial "wireless chain," as well as alternative wireless chains. On March 5, Mr. Bonar Law announced that the Government is to proceed with the erection in this country of a state-owned and operated station capable of communicating with any part of the Empire. At the same time licenses are to be issued to private companies for the erection of stations in this country for radio-communication with any part of the world, subject to the conditions necessary to secure British control. The Marconi Company has thus been granted the license for which it has long asked, and it intends immediately to erect five large power stations to communicate with the Dominions and South America, and five smaller stations for more local traffic. The cost of these stations will be about two million pounds. It seems to us that this extension of long-distance communication will be of immediate benefit to this country, and the ensuing reduction in the tariff may induce the cable companies to co-operate with the radio companies. As Sir Charles Bright points out, this country has considerable leeway to make up; America, for example, uses 3400 kilowatts for its radio stations, and France 3150, while the British Empire only uses 700 kilowatts.

THE Spring Foray of the British Mycological Society will be held at Bristol on April 20–23. Headquarters for the meetings will be at the botany department of the University.

AN exhibition of Carboniferous corals has just been completed by Dr. W. D. Lang and Dr. Stanley Smith in the Geological Department of the British Museum (Natural History). Polished specimens and transparent sections have been prepared to illustrate the structure of each genus, and explanatory diagrams have also been added.

THE second annual general meeting of the National Institute of Industrial Psychology will be held in the rooms of the Royal Society on Tuesday, March 20. Among the speakers will be the Earl of Balfour, Sir Lynden Macassey, Dr. C. S. Myers, Sir Robert Hadfield, and Sir Charles Sherrington.

AT a representative meeting of botanists held at the Linnean Society's rooms on Friday, March 2, it was decided to hold an Imperial Botanical Conference of British and Overseas botanists in 1924 about the beginning of July. An executive committee was appointed, with Sir David Prain as chairman, Mr. F. T. Brooks as honorary secretary, and Dr. A. B. Rendle as treasurer. An invitation to attend the conference will be sent at once to Overseas botanists.

PROF. JOSEPH S. AMES, who gives an account of recent aeronautic investigations in the United States elsewhere in this issue, has been chosen to deliver the eleventh annual Wilbur Wright memorial lecture of the Royal Aeronautical Society. The lecture, the subject of which will be "The Relation between Aeronautical Research and Aircraft Design," will be given at the house of the Royal Society of Arts on May 31.

THE Royal Irish Academy devoted its meeting on February 26 to a commemoration of the centenary of Pasteur. Addresses were delivered by Dr. W. R. Fearon, Prof. A. C. O'Sullivan, and Prof. Sydney Young (president of the Academy), dealing with various aspects of his work, and an address in French by Prof. R. Chauviré dealt with Pasteur as a typical Frenchman.

A SCIENTIFIC superintendent under the Fishery Board of Scotland will shortly be appointed. He will conduct and supervise the scientific fishery investigations which the board may consider necessary, and be in charge of the board's laboratories at Aberdeen. Applications for the post, accompanied by copies of any published papers of the applicants, if deemed desirable, and the names of at least two referees, must reach the secretary of the board, 101 George Street, Edinburgh, by, at latest, March 31.

THE Ministry of Agriculture and Fisheries will shortly appoint an inspector in connexion with agricultural and horticultural education and research. Applicants for the position must have taken a course in science or agriculture at a university or college of agriculture, and should have had special training in the science and practice of dairying. Forms of application and copies of the regulations governing the appointment may be had from the Secretary of the Ministry, 10 Whitehall Place, S.W.1. Application forms must be returned by March 26.

WE have received intimation of the opening at Lake Trasimeno of a laboratory for the study of the biology of the lake, including researches on the fresh-water fishes. The lake, which is about thirty miles in circumference, offers many opportunities for limnological work. It is to be hoped that this new station will receive the support which will justify its continuance. The premises have been provided by the University of Perugia, and Dr. Osvaldo Polimanti, professor of physiology in the University, has been appointed director, and intending workers should communicate with him.

MR. G. M. B. DOBSON will deliver a lecture to the Royal Meteorological Society on March 21 on "The Characteristics of the Atmosphere up to 200 km., as obtained from Observations of Meteors." Meteorological observations in the free atmosphere by means of *ballons-sondes* have not been carried to heights much greater than 30 kilometres, but Prof. Lindemann and Mr. Dobson have recently put forward a method of determining the temperature at much greater elevations by means of observations of meteors (see NATURE, December 9, 1922, p. 794). Those interested are invited to attend the meeting, which will be held in the Society's rooms at 49 Cromwell Road, South Kensington, London, S.W.7.

AT the annual general meeting of the Institute of Metals held on Wednesday, March 7, the following officers for the year 1923–24 were elected :—*President* : Mr. Leonard Sumner. *Past-Presidents* : Sir Gerard A. Muntz, Bart., Engineer Vice-Admiral Sir Henry J. Oram, Sir George Beilby, Prof. H. C. H. Carpenter, and Engineer Vice-Admiral Sir George Goodwin. *Vice-Presidents* : Sir John Dewrance, Mr. W. Murray Morrison, Sir Thomas Rose, Dr. W. Rosenhain, Sir William E. Smith, and Prof. T. Turner. *Honorary Treasurer* : Mr. A. E. Seaton. *Members of Council* : Mr. W. H. Allen, Mr. L. Archbutt, Mr. G. A. Boeddicker, Mr. T. Bolton, Dr. H. W. Brownsdon, Engineer Vice-Admiral R. B. Dixon, Prof. C. A. Edwards, Mr. S. Evered, Dr. R. S. Hutton, Mr. F. C. A. H. Lantsberry, Sir Charles A. Parsons, Mr. H. A. Ruck-Keene, Dr. R. Seligman, Mr. James Steven, Mr. F. Tomlinson, and Mr. H. B. Weeks.

Our Astronomical Column.

GREAT FIREBALL IN NORTHERN INDIA ON DECEMBER 28, 1922.—Mr. W. F. Denning writes that "letters have been received reporting a splendid fireball which appeared over the Punjab at about the time of sunset on December 28. It was observed by a great number of people, and accounts published in the *Civil and Military Gazette* (Lahore) include descriptions from Simla, Peshawar, Balloki, Moghalpura, Sargodha, Jhelum, Rawalpindi, Bakloh, Dharamsala, Lahore, Sharaqpur, Murpur, and other stations.

Many of the accounts are of little service, but Col. W. E. Pye and Lieut. Stephenson at Shagai, Khyber Pass, North-West Frontier, give an excellent description of the phenomenon. The observed path at the latter place was from 6°-43° to 20°-48°, and the fireball exhibited moderately slow motion. It left a long white streak which endured about fifteen minutes. A large number of the observers allude to the streak as perfectly straight at first, but it soon assumed a zig-zag shape, and drifted away from the place of its early projection. At one station the streak, which appeared to be vertical when formed, became horizontal in twelve minutes, the lower end having moved the required distance. At Sargodha, six minutes after the great illumination due to the meteor, loud rumbling sounds were heard, caused by the disruption of the object. These would indicate a distance of 75 miles.

From a comparison of the observations the fireball seems to have been an early Quadrantid with a radiant at 234° + 55°. The height was about 54 to 29 miles, and velocity about 25 miles per second. The luminous course was directed from N.N.W. to S.S.E. It crossed the river Chenab, and ended about 100 miles N.E. of Mooltan.

These results are only approximate. The object was one of great splendour, and it is hoped that further observations will be forthcoming.

STELLAR SPECTRA OF CLASS S.—In the current number of the *Astrophysical Journal* (December 1922) Mr. Paul W. Merrill directs attention to a number of red stars having spectra similar to that of R Geminorum, which differ from any of the well-known types of spectra which form the Harvard classification. In this classification the red stars are known as M and N types and each of these is subdivided, but no stars are known which have a spectra intermediate between them ; M stars have characteristic titanium flutings and N stars carbon flutings. This peculiarity has led to the adoption of a break in the main series of stellar evolution types of spectra.

Thus an M star of increasing temperature becomes consecutively in the evolutionary series a K, G, F, etc., type star, while an N star, also a giant, becomes an Ro, G, F, etc., type star in its progressive stages. Mr. Merrill shows in this paper that the stars he has discussed should properly form a third division of the giant series joining on to the main sequence of evolutionary stages between the types Ma and K. This progression may be likened to three sets of railway lines joining up at two positions near each other and continuing as a single line. Thus :

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           ↙ Ro    Na    Nb    Nc
B A F G K    Ma    Mb    Mc
  ←———      ↖ S    Se
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It is interesting to note that the Harvard classification is based to a great extent on the replacement of metallic lines by ionised lines, and eventually by gaseous lines, the higher the temperature ; but Mr. Merrill points out that while some M stars show ionised lines, so also do the S stars ; this presents, as he says, "an anomalous circumstance which invites investigation."

Research Items.

African Sign Writing.—Mr. C. W. Hobley in the Journal of the East Africa and Uganda Natural History Society, No. 18, March 1923, has given some examples of sign writing collected in East Africa. It includes reproductions of the large fauna of the country, giraffe, elephants, and the like, and their spoor, supposed to indicate to the friends of the artist the presence of game in the vicinity. Others seem to be marks of locality and property. The custom of using signs still survives among the natives. In Togoland, if a man calls on a friend and finds him absent, he will pull a little grass from the roof of his hut and attach it to a stick outside the door to announce to the owner that a visitor has called. Wemba hunters make marks on their arms to record the number of the bigger animals they have killed, and in some parts of Kavirondo the birth of each child is marked by a cicatrisation on the abdomen, possibly with some magical object. The facts collected by Mr. Hobley and the illustrations he has provided are interesting in connexion with the origin of writing.

The Catholic Christians of Eastern Bengal.—Little has hitherto been known of the remarkable community known as the Firingis or "Franks" of Eastern Bengal. The late Dr. James Wise gave some account of them in the very rare volume entitled "Notes on the Races, Castes, and Trades of Eastern Bengal," of which only twelve copies were privately printed in London in 1883, and even libraries like those of the British Museum, the University of Cambridge, and the Royal Anthropological Institute do not possess a copy. Some of the information was, however, copied by Sir H. Risley in his "Castes and Tribes of Bengal." Some fresh details of this curious people have now been collected by Mr. H. E. Stapleton, special officer of the University of Dacca, and published in vol. xvii., 1922, of the Journal of the Asiatic Society of Bengal. They are believed to be descended from the Portuguese pirates who infested the Delta of the Ganges in the sixteenth and seventeenth centuries. They undoubtedly include many converts from the local races, they speak nothing but Bengali, are indistinguishable from Bengalis in dress and means of livelihood, and until recently they made no claim to Portuguese descent. They now number about 8500, but of these, 2000, under the French Fathers, are converted natives and have no claim to the name Firingi.

Productivity of Hill Pastures.—An inquiry conducted into the productivity of hill pastures in Exmoor, Wales, and Northern England ("University of Oxford Institute for Research in Agricultural Economics: The Productivity of Hill Farming," by J. Pryse Howell, London, Oxford University Press, 1922. 1s. net) has shown the value of artificial manuring of pasture and of more intensive cultivation in increasing the production of mutton, wool, and beef per acre. Much improvement in this direction is possible on the lower-lying ground, but it is less practicable on farms with an extensive range of high sheep-walks. The improvement of the latter will always be difficult owing to the considerable cost involved, but the committee of inquiry make certain recommendations which could well be carried out. Much depreciation of flocks occurs, especially in Wales, from the practice of allowing the rams to roam at will over the unenclosed sheep-walks, and it is recommended that a more efficient system of control of rams be instituted and enforced. The management of the "Commons" with grazing rights is very unsatisfactory, and joint action by the commoners is essential if matters are to be improved. Bracken, heather, and gorse are too often allowed to grow unchecked, thus reducing the feeding value of the land, and the systematic burning of heather and gorse, and the eradication of bracken, would prove most advantageous. The mortality among the flocks from various diseases is very heavy, and causes great monetary loss, and the committee emphasise the fact that a systematic inquiry into the diseases affecting sheep is a matter of the most urgent importance.

Rusts in South Africa.—The great economic importance of rusts, owing to the considerable loss in crops that they cause, renders it essential to determine the life history of as many types as possible in order to discover the second host where unknown. Infection experiments have shown that the common rust on *Vigna angustifolia* produces spermagonia and æcidia on this species from October to January, and then infects the Besem gras (*Tristachya rehmani*) by means of æcidiospores (M. Pole-Evans, Union of S. Africa, Science Bull., Nos. 1 and 2 of 1923). Uredospores and teleutospores are produced on the second host, the winter being passed in the latter stage, and with the fresh growth of the Vigna in spring, infection occurs by sporidia developed from the resting teleutospores. This rust on sweet pea and Besem gras is a new species of Puccinia which has not yet been described and named. A similar life cycle has been established for the mealie rust (*Puccinia maydis*), of which the spermagonia and æcidia occur from October to December on *Oxalis corniculata*. This connexion was originally established by Dr. Pole-Evans, and has now been confirmed by these infection experiments. Other species of Oxalis tested proved to be quite immune.

Colour Inheritance in Seeds and Flowers.—In a paper showing the inheritance of certain brown and red pigments in the seeds of soy bean and rice varieties, Mr. I. Nagai (*Journ. Coll. Agric.*, Imp. Univ., Tokyo, vol. 8, No. 1) has also made experiments on the physiology of the pigments involved. They are in two groups, the anthocyanins and the reddish-brown phlobaphenes. The whole subject of the genetic physiology of these pigments is discussed, and the limitations in our knowledge of the relations between genes, chromogens, and enzymes in colour production are pointed out. In the same Journal, Dr. S. Ikeno describes the genetics of flower colour in *Portulaca grandiflora*. The condition of colour inheritance resembles that in various other genera, the factor C producing an orange colour, C + G yellow, C + R red, while magenta, which is probably the original colour, is produced by C, R, and a blueing factor B acting together. R and B generally show complete linkage, but occasional crossing over produces red-flowered plants. Reverse mutations were also obtained, from white to magenta or red, as well as bud mutations, which were already known. Drs. K. Miyake and Y. Imai (*ibid.* vol. vi. No. 4) similarly analyse the flower colours of *Digitalis purpurea*. The purple colour is due to the presence of two factors C and P. When P is absent the flower is white with red spots, while in the absence of C it is white with yellow spots.

The Strength of the Plant Cuticle.—Botanists have recognised the importance of this question since the investigations conducted at the Imperial College of Science under the direction of Prof. V. H. Blackman have led to the conclusion that some parasitic fungi pierce the cuticle of the uninjured plant purely by pressure. They will therefore find considerable interest in the conclusion drawn by recent writers in the Journal of the Textile Institute as to the surprising strength of the cuticle surrounding a cotton hair. From different lines of investigation this result is arrived at by R. S. Willows and his co-workers in the Research Department of Tootal, Broadhurst Lee Co., Manchester, in their experiments upon mercerisation (Journ. of the Text. Inst., xiii. pp. 229-40, December 1922), and by H. F. Coward and L. Spencer upon the absorption of caustic soda solutions by cotton (Journ. of the Text. Inst., xiv. pp. 832-45, Jan. 1923). All these investigators conclude that the swelling of the cotton hair in alkali may be considerably restricted by the resistance to expansion of the cuticle and give cogent grounds for this conclusion. Such a strong cuticle upon a hair which has largely matured within a closed fruit is at first sight a surprising phenomenon. It is interesting to note that H. J. Denham, in his study of the destruction of the cotton hair by micro-organisms (Journ. of the Text. Inst., xiii. pp. 240-48, Dec. 1922), inclines to the view that some of these organisms can penetrate the healthy cuticle. This cuticle resists cold alkalis at high concentration and its hydrolysis by any organism has yet to be detected; but in view of these studies upon its strength, the actual method by which the uninjured cuticle is penetrated would seem to deserve close investigation.

Impounding Water for Mosquito Control.—In Bulletin 1098 of the U.S. Department of Agriculture, 1922, Mr. D. L. van Dine describes a method of controlling the breeding of malaria mosquitoes in the lower Mississippi Valley. In this region the bayous or shallow streams of the delta, with their accompanying vegetation, greatly facilitate the breeding of anophelines. The topography renders drainage impossible, and a trial was therefore made of clearing a section of the bayous and impounding the water so as to convert what was practically a marsh into a lake. The essential points in this method are the preliminary clearing of all vegetation, the provision of a sufficiently high permanent level of water, to suppress the further growth of aquatic and semi-aquatic vegetation, and the maintenance of a clean margin. The experiment thus carried out is stated to have given good results.

Growth of Cassava Plants.—T. G. Mason has an interesting note in the Scientific Proceedings of the Royal Dublin Society, vol. 17, N.S. Nos. 11-13, pp. 105-112, December 1922, upon the growth of some Bitter Cassava plants in St. Vincent, West Indies, under equivalent conditions save that half the plants were ringed through the phloem near the base of the stem, measurements of growth being made both before and after the operation. The experimental results show that this ringing did not affect the growth in length of the shoots for several weeks and then only to a relatively small extent; the fleshy roots, on the other hand, accumulated far less weight of reserve material upon the ringed plants. The author scarcely appears to put the simplest interpretation upon these experimental results when he declines to assume that the normal channel for the passage of this food to the root has been interrupted by cutting through the phloem, but assumes instead that the ring has blocked the passage of some mysterious correlating agency from the dominant apical shoot bud, and that in the absence of this unknown factor normal transmission of organic solutes in the xylem is impossible.

Origins of Petroleum.—In an important paper on the marine kerogen shales from the oil-fields of Japan (Sci. Rep. Tohoku Imp. University, Ser. 3, vol. 1, No. 2, 1922, Maruzen Co., Tokyo), Mr. Jun-ichi Takahashi describes a number of interesting deposits of Miocene and Pliocene age from various islands of the Japanese group, including a series where radiolaria, sponge-spicules, and diatoms are associated with what was originally sapropelic matter. The author concludes that the kerogen has arisen from "nectons and kelps" which have "been repeatedly buried by ash and detritus from submarine volcanoes." He illustrates the memoir by photographs of rocks and marine fossils, and of a remarkable series of thin sections of the sapropelic ooze.

Cannel Coal, Lignite, and Mineral Oil in Scotland.—The Geological Survey has published recently volume xxiv. of its special Reports on the Mineral Resources of Great Britain, which gives an account of a number of minor occurrences of cannel coal, lignite, and mineral oil in Scotland outside the recognised Scottish oil-shale fields. The work has been done by a number of members of the staff of the Geological Survey, and the publication is edited by Dr. W. Gibson. It is of course important that all such occurrences should be put on record, although, as is pointed out in the memoir itself, they have little or no economic value; nevertheless they are of interest to the geologist, and the information here given may prevent waste of money and energy in attempts to develop them.

The Warialda Meteorite of New South Wales.—The Warialda meteorite, which is defined as a fine variety of hexahedrite, has been described, figured, and its analysis given by J. C. H. Mingaye (Rec. Geol. Surv. N.S. Wales, vol. x. part 1). It is identical in crystallographic structure with the Bingera and Barraba meteorites which were found in the same district, and the three are probably products of the same fall, of which it is hoped further specimens may yet be discovered.

Orthopterous Insect Wing in a Selenite Crystal.—In the Mount Elliott Copper Mine, North Queensland, at a depth of 260 feet from the surface, and embedded in a large crystal of selenite, enclosed in the actual copper lode worked in that mine, there has been found a portion of the wing of an Orthopterous insect. This interesting fragment forms the subject of a paper by Dr. R. J. Tillyard in the Records of the Geological Survey of New South Wales, vol. x. part 2. The crystal must have been formed by percolating waters long after the lode itself came into being; its age is, consequently, very uncertain, but the author inclines to the view that it is late Tertiary. The conclusion reached after a careful study of the fossil is that it represents an archaic type belonging to the family of long-horned grasshoppers (Tettigoniidæ), and does not belong to any genus known to exist in the world to-day. Accordingly it has received the name of *Austrodictya corbouldi*, n. gen. et sp., the trivial name commemorating the manager of the mine through whose instrumentality the specimen was saved from destruction and forwarded to the Survey.

New Brunswick Oil-shale and Gypsum Deposits.—Memoir 129 of the Geological Survey of Canada records the geology of the Moncton Map-area, which includes parts of the counties of Westmorland and Albert lying in south-east New Brunswick. Besides giving an account of the general geology of the district, incidentally the geology of the Carboniferous rocks for the most part, the memoir gives some new facts relating to the oil-shale deposits. These shales are associated with certain horizons in the Carboniferous sequence, and an effort has been made to elucidate the structures accurately to enable the extent of the resources available to be calculated. Actual oil and gas possibilities are practically negligible, but the shales at places like Albert Mines and Rosevale are both well known and valuable, while several other localities offer good prospects. Since May 1921, the D'Arcy Exploration Co. (a subsidiary of the Anglo-Persian Oil Co.) has been operating at Rosevale, mainly on experimental lines with a special type of retort (Wallace), and the results have so far proved quite satisfactory. The average recovery of oil from a ton of shale is about 30 gallons, the specific gravity of the product varying from 0·893 to 0·903. This compares favourably with that obtained from the Scotch retort on the same material, where the yield is less and the gravity of the oil usually higher. Some gypsum and anhydrite deposits described from the region also form interesting and economically valuable occurrences: these are in the Hillsborough Series of Mississippian age and are at present being worked in the Demoiselle and Hillsborough basins. The relationship of the gypsum to the anhydrite deposits appears to be obscure here, as is frequently the case elsewhere; but the theoretical problems to be solved have a direct bearing on the future working of the deposits.

CLOUD FORMATION.—The Royal Magnetical and Meteorological Observatory of Batavia, in Verhandelingen, No. 10, gives a discussion by Dr. C. Braak on cloud-formation, nuclei of condensation, haziness, and dimensions of cloud-particles. The data were determined by means of Aitken's dust counter. In addition to the observations made in the East-Indian Archipelago an appendix is given on observations made in the Indian Ocean during a voyage from Java to Europe. Observations were also made on dry fog in the Archipelago as well as in other regions. Individual observations are published, so that the details can be examined. The differences between land and sea are given, and the variations with height above sea-level. The number of nuclei in the open sea under humid conditions was 120 per c.cm., and in the open sea in the dry season 1620 per c.cm.; in the neighbourhood of the land the mean number was 2560. The variation with height above sea-level shows a great decrease in the number of nuclei with increased height. Seasonal variations are considered, dealing chiefly with observations in Java and Sumatra. Much of the haze experienced is attributed to smoke from forest and prairie fires. The size of the particles is said to have a larger influence than their number on the density of haze, careful observations being made with a microscope to test this view. Valuable generalisations have been made on the subject, and these will doubtless be tested by other observers. This paper was taken as the subject for discussion at the evening meeting at the Meteorological Office on February 5, and is referred to in the *Meteorological Magazine* for February.

THE ELECTRICAL CONDUCTIVITY OF GLASS.—The February issue of the Journal of the Franklin Institute contains a communication from the director of the Applied Science Section of the Nela Research Laboratories, giving the results of the research of Mr. L. L. Holladay on the conductivities of glasses at temperatures up to 500° C. Between 20° and 75° C. the resistance from the inside to the outside of the glass tubes used was measured, and at higher temperatures the resistance of a length of the tube. In all the eleven glasses tested the conductivity could be expressed as the product of a constant into a power of the temperature centigrade about $-\frac{1}{2}$, into ϵ, the base of the Napierian logarithms, to the power $-A/T$, where A is a constant and T the temperature centigrade. A table of values of the constants for the glasses tested is given.

HEATING IN ELECTRIC CONDUCTORS.—An important research on the heating of buried cables has just been communicated to the Institution of Electrical Engineers by Mr. S. W. Melsom and Mr. E. Fawssett. Most of the tests were made at the National Physical Laboratory, but some were made under actual working conditions, the cables being laid in all kinds of soils. The rating of a cable depends on the rate at which it can dissipate the heat generated in it by the electric current, and hence it was necessary to calculate what current it could carry under different working conditions. Apparently the thermal conductivity of the insulating material of the cables does not vary appreciably with temperature, and thus the solutions of the thermal problems which Fourier gave in his "Théorie analytique de la chaleur," published in 1822, apply. The thermal constants of various kinds of soil are given, and so by the help of formulæ the maximum permissible currents in the various cases can be readily computed. It was found that in certain cases existing cables could carry greater currents safely, and hence economies can be effected. The research, which was a costly one, has taken several years, and was carried out on behalf of the British Electrical and Allied Research Association.

A RECORDING SACCHAROMETER FOR BREWING.—Messrs. Negretti and Zambra have constructed an instrument known as a hydrograph or recording saccharometer, which is compensated for temperature. It has been designed and constructed to provide a simple and practical means of showing and recording the specific gravity of wort flowing to the under-back, copper, etc. It consists of a cylindrical vessel on the lower portion of which is a ¾-in. pipe, through which the wort is admitted. To prevent eddies in the vessel, an inlet pipe leads into an annular ring, which distributes the flow evenly round the vessel. A cylinder and copper gauze is also provided through which the wort percolates. An outlet pipe at the top of the external cylinder is provided, and here again there is another annular ring over which the wort flows, with the object of preventing eddies. Within the inner copper gauze cylinder a hollow float of thin nickel heavily coppered is suspended. The hollow float is completely filled with the liquid, and is connected with the recording instrument by means of a chain immediately above the vessel. The chain is connected with a grooved quadrant mounted on a knife-edged axis. On the opposite side a weight is provided to balance the float when it is in the liquid, the zero adjustment being provided by an adjustable weight. The indications of the instrument are rendered independent of temperature from the fact that the wort in the cylinder and in the float are at the same temperature. The clock carrying the chart revolves once in six hours, and the graduated portion of the chart is marked from 1000 to 1100° specific gravity, and subdivided to 2° specific gravity, which on the chart is equal to $\frac{1}{20}$th of an inch. The pen marks in a continuous ink line on the chart, and the readings can be made to ½° specific gravity with the greatest accuracy. In an ordinary mash tun, however, the wort from the various taps are often running at different temperatures and at a different specific gravity, so that the measurements made with the wort from one tap will not of necessity give the average specific gravity of the whole wort. The objection does not apply if the wort is drawn off through one spend pipe or is running from the under-back to the copper.

Humanism in Technical Education.[1]

By Sir THOMAS HOLLAND, K.C.S.I., K.C.I.E., F.R.S.

VERY few questions have been more discussed than that of education, and the reason for it is quite obvious; for educational methods are as varied as the students who have to be educated, and perfection can be reached only when a system is designed to meet the special circumstances of each individual. Some plants want pruning, others require fertilising, to produce their best results. One pedagogue thinks discipline should be the cure for all students' evils; others preach the importance of making the work attractive. The clash of ideals is heard most in our technical schools. One authority wants full-scale machinery, another says that the college workshop is merely a misleading caricature of a commercial factory. We are told that the student of science and technology can never become an educated man without a dose, and a fairly large dose, too, of the so-called "humanities"; he must always be narrow otherwise, if not absolutely lopsided, and can never be prepared in an institute of science and technology efficiently to undertake the full duties of citizenship.

In a community of science workers discordant notes are similarly heard. One presses for pure science as the main requirement of the practical technologist; another urges training in purely technical methods. The practical man thinks he has used a very hard word indeed when he calls the science student a theoretical idealist, a dreamer. The student of science pretends to despise the practical man as a mere rule-o'-thumb worker, often, however, because he fails to grasp the principles which underlie, and the long process of expensive research that has evolved, the so-called rule-o'-thumb. The doctrinaire student of science very often is, as some one has said of the early riser, conceited all the morning and stupid for the rest of the day.

It is, however, impossible to lay stress on any one truth without apparently being unfair to some other truth. Somewhere between these extremes the maximum of truth is to be found. It is too often so that where science is taught, the student is crammed with the facts instead of trained in the methods. The product of the science class is sometimes handicapped by what Prof. Huxley, the greatest of my predecessors at South Kensington, called "precocious mental debauchery"—the result of too many bouts of book-gluttony and lesson-bibbing.

I do not intend this evening to follow up any of these apparently divergent doctrines. We have learnt now, if we never appreciated it fully before, that a country cannot defend itself in war, or fight the relentless battles of peace, without science and technology. But the technologist will not remain only an expert in the workshop. He has duties as a citizen and must face relations, and competitive relations too, with other human beings, with most of whom he is unable to communicate in technical terms alone—the technical terms that he learns in the class-room. To be appreciated, he must understand and be understood by others: he wants the "humanities."

Now what is meant by the "humanities"? A dictionary will tell you that classical learning is intended by the same word that we also use for a study of the dispositions and sympathies of man. Sure enough, the study of classical literature once had this meaning. Late in the middle ages the study of the classics revealed to the world the long-buried wisdom, especially of the Greeks—their art, their religion, and, more important, their science. That discovery gave rise to the great movement which we speak of generally as the Renaissance—the revolt of intellect from previous feudalism and theological bondage—resulting not only in the revival of literature, art, and that religious freedom which is generally known as the Reformation, but in the development also of scientific curiosity, what, to avoid the secondary meaning of curiosity, we now call research. It gave us the Copernican for the Ptolemaic reading of the solar system; it gave us also in practical form the mariner's compass and, with the exploratory spirit which accompanied it, the discovery of the Americas, of South Africa, India, and the Far East; it gave us the invention of gunpowder and that of paper and printing, which facilitated the distribution of the new learning to a wide world.

How many of these developments, which succeeded one another with the speed of a revolution, were due to independent origin and from other sources, and how many were quickened by the rediscovery of buried philosophies, we need not stop to inquire; but it is obvious that what would otherwise have been but slow combustion developed, because of this discovery, at the speed of an explosion. That discovery was specially the discovery of humanism in Greek literature. Greek literature acted on medieval scholasticism like nitric acid on a combustible cellulose; cotton was converted into gun-cotton.

The lesson to be learnt from the Renaissance is strengthened by a consideration of what happened afterwards to classical studies. With the passage of time, classical learning like an organism went through a period of vigorous youth, vitalising the world with new energy and new ideas, until it reached the stage of adolescence, and, with it, specialisation.

That is the life-history of every organism. With specialisation the study of the classics became narrowed to its linguistic, grammatical, and purely rhetorical aspects: its main object became obscured and stricken with a formalism and a pedantry that "has given us false ideas, and the narrow spirit of a mutually admiring coterie, that wrote Latin and Greek verses to one another and to no one else. It has engendered a wild form of pedantry that regarded a false concord or a false quantity in Greek, not at all as we should regard a similar mistake in French, but as a shock to the higher order of things, which deserved scorn and reprobation when committed by a man, cruel punishment when committed by a boy."

These are not the words of a prejudiced and jealous scientific man, but the judgment of a distinguished classical scholar, the present Vice-Chancellor of Oxford. Reviewing the situation in this way before the Congress of Universities in 1921, Dr. Farnell pleaded for the revival of humanism in classical studies, and I wish similarly to direct attention to the importance of humanism in science and technology, for we also are exposed to the very same danger that Dr. Farnell says has now nearly strangled classical scholarship in our public schools and younger universities. We can thus learn something from the classics; we can profit by their mistakes, knowing that it is never so easy to recognise our own as the mistakes of others.

[1] From an address delivered at the Sir John Cass Technical Institute on January 31.

During the middle two quarters of the nineteenth century, science went through what we might call its Renaissance period. In its philosophical aspects, it was a revolt in part against a widespread misinterpretation of theology, and, in educational policy, it was a revolt against the dominance of what we regard as a perverted and senile form of the classical humanities. We do not object to the humanities, but to that devitalised residue of the humanities that is without humanism.

I am not now going to discuss the relative merits of science and classics as educational media, but I want to bring home to you the danger of defeating the very end of science itself. Scientific men are also liable to succumb to that form of pedantry which in classics exchanged humanism for grammar and rhetoric, and that homologue of pedantry in most religions which tends to kill doctrine by ritual. Do not let us claim that science can give mental training as good, when really we mean as bad, as that afforded by classics. You may remember what Huxley said of Peter Bell, whose dead soul, according to Wordsworth, saw nothing in Nature :

> " A primrose by the river's brim,
> A yellow primrose was to him,
> And it was nothing more."

Huxley asked if Peter Bell's apathy would have been roused one whit by the information that the primrose is a dicotyledonous exogen, with a monopetalous corolla and central placentation. This additional information would have added no more to the humanising influence of the primrose on Peter Bell than any form of exegetical analysis of a Greek text in exchange for Greek philosophy and Greek art.

Let us take an illustration from one of the departments of this Institute—that of metallurgy. The syllabus of this subject refers to " Bessemer and open-hearth plant and processes." A fair summary of what I, as a junior student, had to learn under this head would be as follows : " The original Bessemer process, as conducted in a ganister (silicious) lined converter, does not effect the elimination of phosphorus from the pig-iron ; but by using a basic (dolomitic) lined converter, Thomas and Gilchrist found it possible to eliminate the deleterious element that affects the quality of the resultant steel, so it is now possible to use a phosphoric pig-iron for steel making." Later, coming under the influence of a professor with a wider outlook of the world, I learnt that this so-called basic process changed the whole of our international relationships. It opened up the enormous phosphoric ores of Germany, Belgium, and America. It resulted, therefore, in a challenge to British supremacy in the steel business. Just think of what that meant to railway development, shipbuilding, machinery, and dozens of dependent industries ! Obviously, realisation of this, to me, quite unforeseen meaning in a purely technical fact opened up a new world of human interest.

Who was Thomas and who was Gilchrist ? Those were the first questions that occurred to one. Thomas, I found, was a magistrate's clerk who attended evening science classes at the Birkbeck, a college having an object similar to that of the Sir John Cass Institute, and named for the same good reason after its founder. Gilchrist was his cousin, and he proved to be much more interesting to me, for he was an old School of Mines student and a Murchison medallist.

Thomas and Gilchrist made, by their invention, a greater impression on the history of civilisation than any two Prime Ministers we have ever had, a greater influence than the sum-total of that exercised by one devoted to optimistic militancy and his counter-irritant, the apostle of tranquillity. Thomas had what the great Mr. Gladstone described, in reviewing his memoirs, as " an enthusiasm of humanity." I am ready to assert that a review on these lines of the way in which the basic process of steel-smelting has affected history, especially when so touched with the human relations of the two men to whom it is due, is all that is necessary for the student. He will soon satisfy his own curiosity about technical details ; he will soon be studying the question himself in the library and the workshop.

This stirring of that form of curiosity that Dr. Johnson called " the thirst of the soul " and " the characteristics of a vigorous intellect " will give human, living interest to a student's work. The teacher's task is three parts done and faithfully fulfilled when he has inspired the student sufficiently to impel him to find out the rest for himself. Nothing appeals to a man like humanity.

In a thoughtful paper read before the Congress of Empire Universities in 1921, Prof. Cecil Desch advocated the adoption of the historical method in science teaching. But history consists of innumerable biographies. As Emerson said, " There is properly no history, only biography." History, divorced from biography, can be as dull and deadening as either Greek grammar or descriptive technology. The educational balance is not secured by requiring students to attend a formal course of classics or history as well as of science. That would be merely to double the offence. A physician does not apply a counter-irritant if he can get at the seat of the disease. It is not separate courses of history and science—a mechanical mixture—that are wanted, but the history of science itself, that is, a chemical compound. Giving two separate doses of two unrelated subjects to act as mutual correctives is equivalent to giving a man a metallic sodium pill with a sniff of chlorine gas, when what he wants is merely a pinch of common salt.

But for the power unwisely given to examiners to make or mar a student's career, I would like to try the experiment of covering a syllabus of, say, metallurgy or chemistry by lectures on biography alone. I believe students could be trusted to fill in the historical frame-work on their own account, and to find out for themselves all that is required in the way of technical details. They shall succeed, of course, in varying degrees just as they do now ; but whether they succeed partially or wholly, all shall be better men for having made an effort inspired by a natural and healthy curiosity ; they shall have had the very training which lays a sure foundation for what the scientific man calls research ; and what the scientific man calls a training for research is the very kind of training which qualifies a man to face the problems of after life, when every difficulty that the student has to face after he has left the institute shall have no apparent resemblance to any question previously treated, either in the lecture-room or the laboratory. Every problem that the student meets with afterwards shall be a piece of new research to him.

Sir Richard Gregory, in his address to the British Association last year, defined education as the " deliberate adjustment of a growing human being to its environment ; and the scope and character of the subjects of instruction should be determined by this biological principle." I agree, and as the technical student's environment will be human beings, with little or no familiarity with his own pet technical terminology, he wants to go into the world with a full appreciation of the human aspects and importance of his special subject.

The Flora of an Indian Island.[1]

As a preliminary to the faunistic study of Barkuda, one of several islands in the Chilka Lake, Dr. N. Annandale has investigated its climate, physical structure, palæontology, and vegetation. The lake is a maritime one in the extreme north-east of Ganjam, and is connected with the Bay of Bengal. The island, some three hundred acres in extent, though isolated for terrestrial animals, is within the range of insects of feeble flight and that of dispersal for many seeds. The climate is that of the coasts of the Circars to the south and Orissa to the north. The physical structure is simple and the geological formation uniform; the rocks are the quartz schists of the Ganjam Malias. The changes in the shore water-level, though of faunistic importance, scarcely affect the vegetation. The rocks contain no fossils, but sub-fossil molluscan shells abound in the soil of the island and the sand of its shores. These shells indicate that the island, as such, is recent; the age of the rocks has no bearing on its existing biological features.

Though the vegetation is restricted, several types occupy different areas. Much of the surface has been colonised primarily by species of Ficus, mainly *F. bengalensis*, with an undergrowth of Glycosmis and a partial thatch of woody climbers. This is gradually replaced by other species of Ficus accompanied by trees like *Melia Azadirachta* and *Strychnos Nux-Vomica*, while the undergrowth is reinforced by Capparis and Zizyphus. The foreshore vegetation is scanty. Where the coast is rocky the species present, though fewer than on sandy or gravelly sections, are arboreal and therefore more conspicuous. Behind the foreshore comes a Pongamia belt, broken in places by intruding Cratæva and Melia. Within this zone, besides surviving Ficus groves with Glycosmis undergrowth, are areas where the latter is replaced by *Weihea ceylanica*, the former by Cratæva, Odina, and Albizzia. Stony areas have a scanty plant-covering; the rock-flora of the interior includes masses of two arboreal Euphorbias, *E. antiquorum* and *E. neriifolia*. The commonest tree on the island is *Melia Azadirachta*; perhaps the most abundant herb indigenous there is *Oldenlandia Heynei*.

Dr. Annandale's ecological sketch is supplemented by a plant-list prepared from his specimens by two members of the Botanical Survey staff. This important adjunct to the paper is somewhat marred by typographical errors, and shows want of uniformity in citation. Messrs. Narayanaswami and Carter have not supplied an analysis of the vegetation from the point of view of plant-distribution to correspond with Dr. Annandale's discussion of the subject from the point of view of plant-association. Their carefully prepared list provides all the material required for the purpose, but they have made it more troublesome for those desiring to ascertain the facts by adopting a taxonomic system which, whatever its academic merits, has the inconvenience of differing from that used in the "Flora of British India."

The affinities of the Barkuda flora are South Indian. The list enumerates 139 plant-forms, of which two may be new while five remain undetermined. The remaining 132 include twenty-one, nearly 16 per cent., not reported from Orissa north of the lake, and seventeen, nearly 13 per cent., never found north of the Dekhan. One species, *Riccia crispatula*, has hitherto only been known from Ceylon; two, *Selaginella tenera* and *Weihea ceylanica*, have only been reported from Ceylon and from India south of the Dekhan. Thirty-five, more than 32 per cent., of the Barkuda species reported from North-eastern India, are themselves indicative of South Indian affinity. Seven are littoral plants that are North-eastern Indian only, because they occur on the Orissa coast and in the Sundribuns. The remaining twenty-eight include ten reported only from Orissa, which is a northward continuation of the Circars, and eleven reported only from Chutia Nagpur, which forms a north-eastern extension of the Dekhan, while the remaining seven have been met with both in Orissa and Chutia Nagpur but not in the Gangetic Plain.

[1] Memoirs of the Asiatic Society of Bengal, vol. 7, No. 4. "Introduction to the Study of the Fauna of an Island in the Chilka Lake," by Dr. N. Annandale.

The Sed Festival of Ancient Egypt.

At a meeting of the Royal Anthropological Institute held on February 20, Mr. P. E. Newberry presented a paper on "The Sed Festival of Ancient Egypt." This was perhaps the most ancient of all the many Egyptian festivals: it was certainly the most important. There are representations of it on monuments from the beginning of the Ist Dynasty down to Ptolemaic times.

Various interpretations of the festival have been given, but none of them are entirely satisfactory. According to the Greek version of the Rosetta Stone, it was a festival marking a period of 30 years, but there are records of it being celebrated in the 2nd, 15th, 22nd, and 25th years of different kings' reigns. It appears to have been a repetition of the festivals of a coronation and its celebration seems to have procured for the king a new lease of life. It certainly had something to do with the king's assumption of responsibility for the protection of Egypt. It should be especially noted that the king's daughters take a prominent part in the festival. On the mace head of Narmer-Menes is the earliest representation of it: here there is a princess seated in a palanquin and behind her are three men in the act of running: this scene is also found in the Sed festivals of Neusere (Vth Dyn.), of Amenhotep III. (XVIIIth Dyn.), and of Osorkon (XXIInd Dyn.), although in the later examples young princesses standing replace the figure in the palanquin. This ceremony is probably the most primitive one of the Sed festival and represents, Mr. Newberry believes, a *race*, and a race for no less a prize than the Kingdom. Frazer in his "Lectures on the Early History of Kingship" (p. 260 *sq.*) notes that something, apparently the right to the hand of the princess and to the throne, has been determined by a race, and he quotes instances from classical and other sources. "Such a custom," he says, "appears to have prevailed among various peoples, though in practice it has degenerated into a mere form or pretence."

Although it is often assumed that the kingship was hereditary, in the male line—that the son regularly succeeded his father on the throne—it is certain that in Egypt the king claimed his right to the kingship, not because he was the son of his predecessor on the throne, but because he married the hereditary princess who might be the widow or daughter of his predecessor. It is obvious, therefore, that the marriage ceremony must have been a very important one in ancient Egypt. Egyptian women marry early in life, sometimes at 10 or 11, oftener at from 12 to 14 years of age. No doubt the same custom prevailed in ancient times. At 13, or even earlier, a girl may be a mother, and from 40 to 45 she becomes incapable of bearing children. When she becomes incapable of bearing children the husband often takes a new wife: this may perhaps explain why the Sed festival was called the 30 years' festival; for if a girl is married, say at 12, she ceases to be able to bear children at 42, just 30 years after her marriage, and her husband takes another wife.

If the hereditary princess predeceased her husband, then it must have been necessary for the king to marry again so as to retain the kingship: this would explain the fact that the Sed festival was sometimes celebrated in years earlier than the 30th year of a king's reign. It also explains why a king sometimes married his own eldest daughter. If the hereditary princess survived her husband, then Mr. Newberry's theory explains why she is sometimes married to her husband's successor. This theory would also give a reason for it being a kind of repetition of the king's coronation and for its procuring for the king a new lease of power.

There is yet another fact which suggests the theory that the Sed festival was a marriage festival. It was celebrated in a booth or tent (called *Sed*) raised high above the ground; and with Semitic peoples the tent plays a very important part in marriage ceremonial, as Robertson Smith notes in his "Kinship and Marriage," p. 198 ff.

Chemistry in Industry.[1]

NATURAL science—and in this connexion chemistry must be given a position of great prominence—is by far the most important dynamic factor in human progress. Notwithstanding its liability to abuse, its discoveries have, on the balance, made enormously for the greater good and greater happiness of the human race.

The direct utilisation by the State of the services of the professional chemist is a matter not only of immediate concern to chemists themselves, but also of high importance to the community at large, and it is one of the functions of the Institute of Chemistry to ensure that the relations between the appointing authorities and those who hold official chemical positions are of a satisfactory character. Unfortunately, some public bodies do not appear to be aware of the lengthy and expensive nature of the chemist's training or of the difficulties and responsibilities connected with his work, and consequently the advertised conditions of some public posts are not commensurate with the importance of the services demanded. There is a tendency on the part of local authorities to utilise the services of unqualified or imperfectly trained persons for carrying out what are regarded as simple routine processes, a practice against which the council of the Institute has protested vigorously on the ground that it constitutes a serious danger to the community and involves a waste of public money.

The disinterested zeal of the scientific worker is without parallel in the whole world, but it is not wise for any country to presume too much on this disinterestedness. Science is one of the greatest and freest of all givers, but it has a right to demand that recognition in the councils of the nation to which it is entitled. The indirect effect of proper State treatment is very great and the rulers of Germany know this well. A leading German industrial chemist said recently that notwithstanding Germany's position of virtual bankruptcy, the State, at the instigation of the commercial committee of the Reichstag, had come to the help of the great chemical and physical societies, particularly to that of the Kaiser Wilhelm Institute, and if the State could not continue financial aid, the German people themselves must give their last mark to maintain science.

Although the supply of qualified chemists exceeds, for the moment, the demand, there is no cause for serious alarm. The profession attracted a larger number of young men during the last four years than in any previous corresponding period. Notwithstanding the increased output from the colleges and the intense industrial and commercial depression, the new members of the profession are being steadily absorbed. This absorption may be taken as a definite indication that chemistry is more highly valued by the manufacturer than formerly, and that the leaders of industry and commerce are turning more and more to science to assist them in the solution of their various problems.

[1] From an address delivered to the Institute of Chemistry at the annual general meeting on March 1, by Mr. A. Chaston Chapman, F.R.S.

An Intestinal Parasite of Man.

WE understand that Sir Ronald Ross is engaged at the Ministry of Pensions in the investigation of *Giardi intestinalis*, often known as *Lamblia intestinalis*, which, of the three or four common flagellates inhabiting the intestine of man, has the greatest claim to pathogenicity. Moreover, it differs from the others in being an inhabitant of the duodenum and upper part of the small intestine instead of the large intestine. It is probably the first parasitic protozoan to have been observed, for, as Dobell has pointed out, the famous Dutch observer Leeuwenhoek saw it in his own stools so long ago as 1681. From that time down to the present day there has been much controversy as to the significance of its presence in the human intestine. Some regard it as a definitely harmful organism, while others believe that it does not damage its host in any way.

The frequent occurrence of the flagellate in enormous numbers in certain cases of mucous enteritis seems to suggest that it may sometimes be pathogenic, though, like parasitic amœbæ and bacteria which are known factors in disease, it often occurs in perfectly healthy individuals, who are to be regarded as carriers. American workers have brought forward evidence that *Giardia intestinalis* may invade the bile duct and gall bladder and cause irritation in these organs. Flagellates belonging to the same genus occur in domestic animals, such as dogs, cats, rats, and mice, but it appears that these are distinct from the human form, though Grassi and others believed that human beings became infected by ingesting the encysted forms of the flagellate which escape in large numbers in the dejecta of these animals. Careful experiments have, however, shown that it is not possible to infect animals with the human parasite, and slight morphological differences point to the existence of a number of distinct species.

Reproduction of the flagellate is by a complicated process of binary fission. The organism also becomes encysted in ovoid cysts within which division into two takes place. These cysts are found in the dejecta, and are responsible for the spread of infection. It is only during periods of diarrhœa that the free-swimming flagellates occur in the stool, so that infection of human beings is generally recognised by the discovery of the cysts. There is no known method of ridding a human being of infection, and if it is correct that the flagellate may sometimes damage its host, the outlook for these unfortunate individuals is not a bright one.

University and Educational Intelligence.

Belfast.—At the recent meeting of the Senate of the Queen's University, it was announced that the bequest of 57,000*l.* from the late Henry Musgrave, a well-known benefactor of the University, had been paid. Of this sum 30,000*l.* is left to the absolute control of the Senate, to be used and applied for such purpose as the Senate shall consider necessary. Mr. Musgrave directed that 7000*l.* be invested, and the income applied towards paying an additional reader in connexion with the chair of physics. The sum of 20,000*l.* is to be invested, and the income applied in perpetuity for the promotion and encouragement of research in pathology, physiology, physics, biology, and chemistry. The income is to be applied in founding and maintaining studentships for promoting research in these subjects. Each studentship shall be held for one year, but if the electors are satisfied with the work of the student he may be elected for a second year but no longer. If at any time there shall not be any suitable candidate, or if in any year there be a surplus, such surplus shall form a fund out of which special grants may be made to graduates of the University engaged in research. The Senate has agreed that the annual value of the studentships shall be 200*l.*, and has appointed Prof. Ashworth, Prof. Lorraine Smith, Sir Joseph Larmor, and Prof. Collie, together with Prof. Symmers, Prof. Milroy, Prof. Morton, Prof. Small, and Prof. Stewart, to be the electors of the above studentships.

Mr. R. C. Johnson, Balliol College, Oxford, has been appointed lecturer in physics in succession to Dr. Gray, who resigned his appointment in December; Mr. S. P. Mercer, head of the Seed Testing Department of the Government of Northern Ireland, has been appointed lecturer in agricultural botany and plant diseases.

Bristol.—The Long Fox lecture will be delivered by Prof. F. Francis on Tuesday, March 27, at 5 o'clock. The subject will be "The Relation between Chemistry and Medicine."

The Coombe Memorial Scholarship, of the annual value of 60*l.* and tenable in the faculty of engineering of the University of Bristol, will be offered for competition for the first time this year. The scholarship has been established by the Engineering and the National Employers' Federations (West of England Association) as a memorial to a former president, and will be open to candidates who habitually reside within the area of the Association, which includes the counties of Gloucester, Somerset, Wilts, Devon, and Cornwall, as well as the city of Worcester and the towns of Hanley Castle, Malvern, Malvern Wells, Pershore, and Newport, Mon. The examination will be held at the Merchant Venturers' Technical College on Wednesday, July 4 next, and applications must be sent to Mr. A. Storey, director of the Association, not later than July 1.

Cambridge.—The Adams prize for an essay on "The Theory of the Tides" has been awarded to Mr. J. Proudman, Trinity College, director of the Liverpool University Tidal Institute. The essay submitted by Mr. H. Jeffreys, St. John's College, is highly commended.

Prof. H. A. Lorentz, of Haarlem University, will on May 15 deliver the Rede lecture on "Maxwell's Electromagnetic Theory."

On the conclusion of the last of the courses for naval officers held in the University since the termination of the war, the First Lord of the Admiralty has written to express the thanks of the Board of the Admiralty for the great service which the University has rendered the Navy. He expresses the hope that in some shape or other the intimate association between the two may still be kept alive for the mutual benefit of both.

Mr. M. B. R. Swann, University demonstrator in pathology, has been elected fellow and lecturer at Gonville and Caius College.

Edinburgh.—On Thursday, March 1, the Right Hon. David Lloyd George delivered his address as Lord Rector to the students.

Mr. Lloyd George was afterwards entertained at lunch in the Union, and in replying to the toast of his health referred to the fact that seven of his colleagues in the late Government were graduates of Edinburgh. He dealt in an impressive manner with the relation of the universities to the War. He confessed that although he had known the part played by the universities in building up national efficiency, he never realised till the days of war what a national asset a great university was. He doubted very much whether the rich men of this country quite realised at the present moment what a national reserve a university is. After referring to the new kind of warfare developed by an enemy which was the most highly trained intellectual machine probably in the world, Mr. Lloyd George said the moment came when we called upon our universities, and they came to our rescue and poured out their trained minds—in the War Office, at the Admiralty, at the Ministry of Munitions—bringing the whole resources of their scientific knowledge, and, what was still more, knowing where to place their hands on people who had the training to enable them to take up the problems. He continued—"I don't know, I tell you now, what would have happened to us if we had not had the universities to fall back on in those dark days. I will tell you more. In the end our university brains beat theirs. War, you may say, is not what universities are for. I agree, but war is the great test of the nerve of a nation, of the muscle of a nation, of the heart of a nation. It tests every faculty of the human mind as well as the human body, and the test came; and in every particular, on land and sea, where scientific knowledge was required, where trained ingenuity was needed, we defeated the foe. That was due to the universities. Therefore I regard universities not merely as the great training-ground . . . I regard them as the fourth arm of defence for the security of this land."

Mr. Lloyd George warmly eulogised the services rendered by Principal Sir Alfred Ewing at the Intelligence Department, and stated that the work he did there gave information which ultimately brought America into the war.

Leeds.—The Honorary Degree of Doctor of Laws was conferred upon Major the Right Hon. Edward Frederick Lindley Wood, president of the Board of Education, on March 5. Prof. Barbier, in presenting Mr. Wood, said: "The University desires to do honour to one who, the scion of a Yorkshire family of high distinction, is himself 'commended for the gifts that come from learning.' Mr. Edward Wood has won the respect of his fellow countrymen by the grave sincerity of his judgment. He holds an office of onerous responsibility in our public education. And by his unselfish generosity he has given to the transfer of an historic mansion the grace of a great benefaction to the city of Leeds."

London.—Applications are invited by the senate for the Ramsay Memorial chair of chemical engineering tenable at University College. Particulars are obtainable from the Academic Registrar, University of London, South Kensington, S.W.7.

Sheffield.—At the meeting of the Council on March 9 the following appointments were made: Mr. G. Grant Allan, to be assistant bacteriologist; and Mr. H. P. Lewis, to be assistant lecturer in mining geology.

Societies and Academies.

LONDON.

Royal Society, March 8.—A. B. **Wood**, H. E. **Browne**, and C. **Cochrane**: Determination of velocity of explosion-waves in sea-water; variation of velocity with temperature. An accurate determination of the velocity of explosion-waves in the sea gives:

(*a*) $V = 4955 \cdot 5$ (± 1) ft./sec., at $16 \cdot 95$ ($\pm 0 \cdot 1$)° C. and salinity 35 per cent.

(*b*) $V = 4836$ (± 2) ft./sec., at $6 \cdot 0$ ($\pm 0 \cdot 1$)° C. and salinity $35 \cdot 1$ per cent.

(*c*) $V = 4847$ ($\pm 1 \cdot 5$) ft./sec., at $7 \cdot 0$ ($\pm 0 \cdot 1$)° C. and salinity $35 \cdot 2$ per cent.

In the new technique developed, it is unnecessary to know the exact position of charge relative to receivers. The results lead to a mean value of $10 \cdot 9$ ft./sec. per ° C. as the temperature-coefficient of velocity in the range 6° C. to 17° C. The following expression represents the velocity at any temperature t° C. within this range, and at any salinity S (parts per thousand):

$$V = 4627 + 13 \cdot 7t - 0 \cdot 12t^2 + 3 \cdot 73S.$$

The salinity-coefficient is approximately 3 to 4 ft./sec. per 1 per cent. increase of salinity, the theoretical value being $3 \cdot 73$ ft./sec. per 1 per cent. No change was detected for charges varying in weight from 9 oz. to 300 lb. of explosive and no variation with depth. The coefficient of adiabatic compressibility of sea-water at $16 \cdot 95$° C. and 35 per cent. is $C_p = 42 \cdot 744$ $(\pm 0 \cdot 02) \times 10^{-6}$. Combining this with Ekman's value of C_θ, the ratio of the specific heats of sea-water under these conditions of temperature and salinity is $\gamma = 1 \cdot 0094 \pm 0 \cdot 0005$, in good agreement with $1 \cdot 0090$, deduced from thermo-dynamic data.—P. M. S. **Blackett**: The study of forked alpha-ray tracks. Forked alpha-ray tracks obtained by the Wilson condensation method were studied. The lengths of the tracks of the recoil atoms yield information concerning the relative ionisation due to different kinds of ionising particles, and of the average charge carried by them. Measurements of the angles between different parts of the tracks gave the masses of the recoil atoms in three particularly favourable cases.—A. **Egerton**: On the vapour pressure of lead.—I. The vapour pressure is measured by effusion of vapour at low pressure through a hole of measured area. Temperature is maintained constant by a selenium cell relay arrangement within 1/3° C. for many hours at about 800° C. Pressures were measured to 10^{-5} mm. The vapour pressure of ordinary lead between 1200-600° absolute is expressed by the equation $\log p = 7 \cdot 908 - 9932/T$. The latent heat of vaporisation of lead (λ_0) is $47{,}000 \pm 1000$ cal. The chemical constant of lead is $1 \cdot 84 \pm 0 \cdot 2$, agreeing well with the theoretical value ($1 \cdot 853$) obtained from the relation $3/2 \log M - C_0 = C$. The vapour pressures of lead and the uranium-lead isotope appear to differ by 2 per cent., but the result is rendered uncertain by an unexplained lowering of vapour pressure which lead undergoes on prolonged heating *in vacuo*.—A. C. **Egerton** and W. B. **Lee**: (1) Some density determinations. The Archimedes method of determining densities is rendered more accurate by utilising certain mobile and heavy organic liquids which avoid air bubbles and damping difficulties, and increase the weight of liquid displaced. Ethylene dibromide and carbon tetrachloride were employed with accuracy. A satisfactory sample of metal for density determination is prepared by filtering, casting, and heating *in vacuo*. The density of lead is $11 \cdot 3437$ at 20° C. The probable error of the nine determinations on three different samples is 1 part in 100,000. The maximum departure from the mean value for any single determination is less than 1 part in 12,000. A sample of uranium-lead would have an atomic weight of $206 \cdot 26$ from the density obtained. (2) Separation of isotopes of zinc. Two sets of distillations of pure zinc have been carried out in high vacuum, under conditions to obtain a slightly different concentration of the isotopes in the final residue of the final distillate. The samples are cast *in vacuo* and seeded with a particular kind of zinc. The first distillations gave a residue of slightly increased density, but the distillate possessed the same density as the original zinc. The second distillations gave a residue of increased density (about 1 part in 3700) and a distillate of decreased density (about 1 part in 3000). Determinations on seven samples of ordinary zinc give the density of zinc (prepared in the described way) as $7 \cdot 1400$ (the probable error being less than 1 part in 100,000). Flaws, allotropes, different physical conditions, and impurities are improbable. The amount of the separation agrees with Dempster's observations of isotopes of weights extending over six units (namely, 64-70), but is not so great as might be found for equal parts of 64 and of atoms of weights 66, 68, and 70.—E. **Hatschek** and P. C. L. **Thorne**: Metal sols in non-dissociating liquids. I.—Nickel in toluene and benzene. Very stable sols of nickel in a medium free from ions can be produced by decomposing nickel carbonyl dissolved in mixtures of toluene and benzene, containing a small amount of rubber, at 100° C. In the electric field the particles of disperse phase move to, and deposit on, *both* electrodes. Electrophoresis in fields of different strengths, all other factors being equal, shows that the amounts deposited are proportional to the first, or a lower, power of the potential gradient. Therefore positively and negatively charged particles are originally present in the sol. The sol resembles typical protected aqueous sols, inasmuch as it is coagulated by liquids which are not solvents for the protective colloid, *i.e.* rubber. The coagulum is only very imperfectly peptised again by rubber solvents, such as toluene or benzene.—H. **Hirata**: Constitution of the X-ray spectra belonging to the L series of the elements.

Zoological Society, February 6.—Sir S. F. Harmer, vice-president, in the chair.—Oldfield **Thomas**: (1) A new rock-kangaroo, *Petrogale godmani*, sp. n. It is like *P. assimilis*, but with a whitish tail, broader nasals, and larger secator. Its habitat is Black Mountain, near Cooktown, N. Queensland. (2) Skull of a pygmy fruit-bat from Sumatra. The generic name Æthalops is proposed.—C. A. Adair **Dighton**: Coat-colour in greyhounds.—E. G. **Boulenger**: The experiments of Dr. Kammerer and others upon amphibians and insects.—E. Leonard **Gill**: The Permian fishes of the genus Acentrophorus.—Charles F. **Sonntag**: On the vagus and sympathetic nerves of the terrestrial carnivora.—E. P. **Allis**: The postorbital articulation of the palato-quadrate with the neurocranium in the Cœlacanthidæ.—G. S. **Giglioli**: On the linguatulid arachnid, *Raillietiella furcocerca* (Diesing, 1835), Sambon, 1922.—Mrs. Rita **Markbreiter**: Some Microfilaria found in the blood of birds dying in the Zoological Gardens, 1920–1922.

February 20.—Dr. A. Smith Woodward, vice-president, in the chair.—D. **Seth-Smith**: Sexual display of the Magnificent Bird-of-Paradise (*Diphyllodes magnifica hunsteini*).—Einar **Lönnberg**: Remarks on some palearctic bears.—E. W. **Shann**: The embryonic development of the porbeagle-shark, *Lamna cornubica*.—Robert **Gurney**: Some notes on *Leander longirostris*, M.-Edwards, and other British prawns.

Faraday Society, February 19.—Sir Robert Robertson, president, in the chair.—A. W. **Porter** and J. J. **Hedges**: The law of distribution of particles in colloidal suspensions with special reference to Perrin's investigations. Pt. ii. The behaviour of particles specifically lighter than the medium has been examined in regard to distribution with height, using for the purpose emulsions of paraffin in water. The change of concentration occurs only at the bottom of the containing vessel. There is an increase of concentration with height reckoned from the bottom. A type of curve is suggested which fits closely the experimental results.—D. B. **Macleod**: On a relation between surface tension and density. The empirical relation $\gamma/(\rho_l-\rho_v)^4=C$, where γ is the surface tension at any temperature, ρ_l and ρ_v the densities of the liquid and the vapour at the same temperature and C is a constant for each liquid, fits the experimental figures with remarkable accuracy for temperatures ranging from the melting-point to the critical temperature.—D. B. **Macleod**: (1) On a relation between the viscosity of a liquid and its coefficient of expansion. If x_0 be the volume of the free space in 1 c.cm. of a liquid at 0° C. and $1-x_0$ the volume occupied by the molecules, it is assumed that at a temperature t° C. the volume of the free space is $x_0+\alpha t+\beta t^2+\gamma t^3$—the volume of the molecules remaining constant. The viscosity of liquids is expressed as a function of the free space, thus $\eta_t x_t^A=C$. For normal liquids A is nearly unity. For associated liquids it has a higher value. The values obtained for the free space for various liquids at their boiling-points are practically constant and of the order required by Van der Waal's theory. An expression is given for the viscosity of liquids at different temperatures and pressures. (2) On the viscosity of liquid mixtures showing maxima. The viscosity of liquid mixtures is a function of the free space of the constituents and of the mixture. In the case of liquid mixtures showing a maximum, the increase of viscosity is due mainly to the increase of density, which in turn is due to the chemical affinity between the constituents. It is probable that complexes which are formed further reduce the free space and consequently increase the viscosity.—F. H. **Jeffery**: Electrolysis with an aluminium anode, the anolyte being (1) solutions of sodium nitrite, (2) solutions of potassium oxalate. With solutions of sodium nitrite probably the primary product of reaction at the anode is aluminium nitrite which is hydrolysed rapidly to hydrated aluminium oxide and nitrous acid, the latter giving rise to nitric oxide and nitric acid. With solutions of potassium oxalate the product of reaction at the anode is a complex anion derived from aluminium. The salt $K_3\{Al(C_2O_4)_3\}\cdot 3H_2O$ can be derived from the anolytes after electrolysis. It is probable that the salt is a true complex salt comparable with potassium chromioxalate, and if this be true, the alumini-oxalate complex can be represented in three dimensions just as Werner represented the chromioxalate. The isolation of a complex salt from an anolyte does not imply necessarily that the constitution of the anionic part of this salt is identical with that of the complex anion present in the anolyte after electrolysis.—Maurice **Cook**: Crystal growth in cadmium. Evidence has been obtained that unworked crystals can grow under certain conditions. The usual methods of preparing metallic specimens for microscopic examination are useless, since the specimen cannot be regarded as unworked after it has been sawn off the original, ground, and polished. In these experiments the metal is cooled in such a way as to be free from the stresses usually set up during solidification. The results obtained indicate that during annealing considerable crystal growth has taken place. Irregularity in the shape of the grains is probably a factor greatly facilitating crystal growth.—S. D. **Muzaffar**: Electric potential of antimony-lead alloys. Measurements of the electric potential of the antimony-lead alloys were made by means of a quadrant electrometer against a calomel electrode in N KOH, N $Pb(NO_3)_2$, and tartar emetic with tartaric acid solutions. The results reveal an identity of potential up to 98 per cent. antimony with that of lead, which show the formation of no solid solution and no chemical compound between the two metals.

Royal Microscopical Society, February 21.—Prof. F. J. Cheshire, president, in the chair.—Sir W. M. **Bayliss**: Colloids and staining. The histologist is concerned with the staining of particles, large or small, sometimes present in the living cell, sometimes formed by fixing agents. The process is a complex one; but, as would be expected from the heterogeneous nature of the systems concerned, adsorption is the chief factor, especially in its electrical aspect; chemical combination seems to be of less importance. Thus, surfaces with a positive charge take negative (" acidic ") dyes, those with negative charge take " basic " or positive dyes. The degree depends on the magnitude of the charge, as shown by the effect of electrolytes, alcohol, heat, isoelectric point, etc. The removal of the amino groups from proteins has no effect on the process. Adsorption can be distinguished from chemical combination in certain cases, such as silk dyed with the acid of Congo-red. The fixation of stains by heat is difficult to explain. The action of mordants is also obscure; chemical combination as " lakes " is only a partial explanation, since these are stated to be resistant to acids. Differentiation appears usually to be a process of colloidal dispersion of the " lake." In a few cases, as the staining of fat by Soudan III., partition in accordance with solubility is the main factor. A. **Mallock**: The resolving power and definition of optical instruments. Resolving power is taken as indicating the least distance (angular or linear) at which two points can be seen as separate in the field of the instrument; definition is the ratio of that area of the field over which the resolving power is maintained to the whole area, or, shortly, the dimensions of the least objects appreciable and the range over which the appreciability extends. Optical images are formed when and where a number of paths from one point to another have the same optical length, in which case either point may be considered as the image of the other. By optical length is meant the length measured in wave-lengths in the medium through which the path proceeds. The constancy of this length causes all the waves emanating from one of the points to arrive at the other in the same phase, and this condition may be used to determine the form of the reflecting or refracting surfaces required to make one point the image of another. Resolving power depends on the rapidity with which the length of the optical path varies as the distance from the geometrical focus is increased: the more rapid the variation the greater is the concentration of the light and the smaller the luminous area which forms the image of a point. For telescopes where the angular aperture of the lens is small the variation is proportional to the diameter of the object glass, and a perfect lens one inch in diameter should have a resolving power of 4 in. of arc. For microscopes where the angular aperture of the lens is large the least appreciable distance is about $\lambda/2$ or 1/100,000 in. with ordinary light. Test plates for microscope objectives consist of groups of fine lines ruled on films of anilin colour, the thickness of which is only a small fraction of a wave-length of light.

Paris.

Academy of Sciences, February 19.—M. Albin Haller in the chair.—G. **Urbain**: Celtium, element of atomic number 72. A discussion as to the priority of Coster and Hevesy. The author cites the earlier work of Dauvillier and himself, and concludes that Coster and Hevesy were not the discoverers of element 72, but have only found a material in which it is present in a relatively high proportion. The author claims that the name celtium has priority over hafnium for this element.—J. L. **Breton**: Spark-gaps in which the spark in a gaseous dielectric is deflected by a strong air current. Two types of spark-gap are described. The simpler of the two consists of a conducting disc of metal or graphite rotating with a high velocity in a hermetically closed cylinder filled with coal gas or the vapour of alcohol. The sparks play between this disc and two graphite electrodes. Long uninterrupted working is secured by water-cooling or by a fan. The apparatus has been successfully applied to the working of a high-frequency-induction furnace.—Jules **Andrade**: Isochronism and quadratic friction.—Georges **Friedel**: Cholesteric bodies.—C. **Sauvageau**: The prolonged quiescent state of an ephemeral Alga (Mesogloia).—M. W. C. Brögger was elected a foreign associate in the place of the late M. Schwendener.—A. **Myller**: Systems of curves on a surface and the parallelism of M. Levi-Cività.—M. **Juvet**: A generalisation of Jacobi's theorem.—M. **Malaval**: Permanent deformations by extension and compression.—M. **Mesnager**: Observations on the preceding note.—P. **Dumanois**: An aerodynamical arrangement for testing motors. The usual fan resistance does not permit of continuous variation. The author encloses the fan in a cylindrical drum closed by two plane parallel walls, one of which is constructed of radiating shutters. By partially opening the shutters, when fixed to a 12 h.p. motor, the number of turns per minute can be varied between 950 and 1470, a sufficient variation for practical conditions of use.—M. **Rateau**: Remarks on the preceding communication. M. Dumanois' apparatus has advantages over the Froude brake.—A. **Weinstein**: The unicity of sliding movements.—Charles **Bohlin**: The autologous series belonging to the problems of two and three bodies.—Ernest **Pasquier**: A simple expression of the acceleration of mercury in the case of the problem of two bodies, taking into consideration the movement of the perihelion of the planet.—Thadée **Peczalski**: The relation between Young's modulus and the ratio of density to atomic mass. The relation $E = B(\delta/M)^2$ is deduced, in which E is Young's modulus, δ is the density, M the atomic mass, and B a constant (8×10^5 kilograms per sq. mm.). The calculated and experimental values are compared for nine metals.—A. **Marcelin**: Superficial fluids. The unlimited extension of oleic acid. A study of the "superficial pressure" exerted by a thin layer of oleic acid on water. When the layer of oleic acid is one molecule thick the acid may be regarded as being in an intermediate state between the free and dissolved states, to which the name of "superficial solution" is given.—St. **Procopiu**: The appearance of the flame, arc and spark lines in the arc-spectra of metals in a vacuum.—Albert **Portevin** and François **Le Chatelier**: A phenomenon observed during the test by extension of alloys in course of transformation. The peculiarity observed was confined to aluminium alloys of the duralumin type with or without the addition of other metals (manganese, zinc). The elongation of the test pieces, instead of increasing continuously with the pull, progressed by repeated oscillations of an amplitude amounting to 4 per cent. of the load and with a frequency of several oscillations per second. The phenomenon attained its maximum amplitude immediately after tempering.—A. **Bigot**: The action of heat on kaolins, clays, etc. Black pottery. A study of the black pottery from the Bouchets Cave (Ardèche), from Basutoland, and of Etruscan black vessels.—André **Brochet**: The hydrogenation and dehydrogenation of castor oil and its derivatives. Castor oil with active nickel was treated with hydrogen at 150° C. under pressure. The pressure showed a series of oscillations which can be interpreted by assuming a series of hydrogenations and dehydrogenations. The fully hydrogenated product gave off hydrogen on heating with nickel to about 280°, but the product finally obtained did not correspond with the original oil.—René **Locquin** and Sung **Wouseng**: the hydration of the dialkylethinylcarbinols and the preparation of the α-hydroxymethyl ketones. Tertiary acetylenic alcohols of the type $RR.C(OH).C\equiv CH$ are readily converted into the ketones $PR.C(OH).CO.CH_3$ by Denigès' reagent (acid sulphate of mercury). Details of the method are given and a description of five ketones prepared by this general method.—Henry **Joly**: Stratigraphical observations on the Oxfordian and Lusitanian at certain points in the Celtiberic chain (Spain).—Léon **Bertrand** and Antonin **Lanquine**: The large Provençal sheets of Audibergue and Cheiron (Maritime Alps).—E. **Schnæbelé**: The present structure of the primary Vosges. The application to the whole of the Vosges of observations made especially to the north of the valley of Villé.—L. **Giraux**: The geological position of the neolithic workshops of the forest of Montmorency.—J. **Beauverie**: The relations existing between the development of wheat rust and climate. The sharp contrast between the climatic conditions in 1921 and 1922 showed that *Puccinia triticina* is especially the rust of dry seasons and *P. graminis* is the rust of wet seasons, the latter doing the most damage from the point of view of yield of grain.—M. **Rose**, J. **Dragoiu**, and F. **Vlès**: The reversibility of the phenomena of arrest by lowering the *p*H in the evolution of the eggs of the sea urchin.—M. and Mme. G. **Villedieu**.—The action of insoluble oxides on the mildew of potato (*Phytophthora infestans*). It is generally admitted that for a substance to act on a living organism it must first be rendered soluble. Experiments on the toxic action of the insoluble oxides of various metals (magnesium, cadmium, nickel, cobalt, zinc, copper, mercury) on the conidia of potato mildew are in direct contradiction with this hypothesis.—R. **Herpin**: Comparison between the sexual behaviour of some nereidians from the coasts of the Channel.—Ch. **Gravier**: Remarks on the preceding communication.—Auguste **Lumière**: The possibility of realising intestinal disinfection. An account of some experiments with sodium argentothioglycerine sulphonate, $AgS.CH_2.CH(OH).CH_2.O.SO_3Na$. Experiments on a dog showed that while a dose of 1 gm. of benzonaphthol per day had no effect on the number of organisms in the fæcal matter, the administration of the same weight of the silver compound sterilised the intestine in four days.

Official Publications Received.

Report of the Canadian Arctic Expedition, 1913-18. Vol. 6: Fishes and Tunicates. Part H: Ascidiacea. (Southern Party, 1913-16.) By A. G. Huntsman. Pp. 14. Vol. 7: Crustacea. Part G: Euphyllopoda. By Frits Johansen. Pp. 34. Part N: The Crustacean Life of some Arctic Lagoons, Lakes, and Ponds. (Southern Party, 1913-16.) By Frits Johansen. Pp. 31. Vol. 8: Mollusks, Echinoderms, Cœlenterates, etc. Part G: Alcyonaria and Actinaria. By Prof. A. E. Verrill. Pp. 164. Part I: Hydroids. By C. McLean Fraser. Pp. 5. (Ottawa.)

Minutes and Proceedings of the Institution of Civil Engineers; with other Selected Papers. Edited by Dr. H. H. Jellcott. Vol. 214. Pp. iv+362+6 plates. (London: Gt. George Street.)

Department of Fisheries, Ceylon. Bulletins of the Ceylon Fisheries. Vol. 1, Bulletins 1-3. Edited by Dr. J. Pearson. Pp. iv+134. (Colombo.)

Forest Bulletin No. 48: Note on Kindal or Hongal (*Terminalia paniculata*, W. and A.). By R. S. Pearson. Pp. 12. (Calcutta: Government Printing Office.) 6 annas.

Forest Bulletin No. 52: Classification of Thinnings. Pp. 5+7 plates. (Calcutta: Government Printing Office.) 6 annas.

Department of Agriculture and Natural Resources: Weather Bureau. Annual Report of the Weather Bureau for the Year 1919. Part 4: Hourly Results of the Observations made at the Magnetic Observatory of Antipolo, near Manila, P.I., during the Calendar Year 1919. Pp. 47. (Manila: Bureau of Printing.)

The Journal of the Institute of Metals. Edited by G. Shaw Scott. Vol. 28. Pp. ix+1010. (London: 36 Victoria Street.) 31s. 6d. net.

Diary of Societies.

SATURDAY, March 17.

British Mycological Society (in Botany Department, University College), at 11.—Rev. P. J. Alexander: An Ecological and Phenological Account of the Mycetozoa of Surrey.—Miss M. H. Carré, Dr. A. S. Horne, Miss H. M. Judd, and Mrs. H. S. Williamson: Eidamia.—Dr. J. S. B. Elliott and Miss O. Stansfield: The Life History of *Polythrincium Trifolii* Kunze.—J. Ramsbottom: (1) The Correspondence of Berkeley and Broome; (2) Mycology at the British Empire Exhibition (1924).

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (5).

MONDAY, March 19.

Royal Geographical Society (at Lowther Lodge, Kensington Gore), at 5.—Col. M. N. MacLeod, Squadron-Leader F. C. V. Laws, and Major Griffiths: Recent Developments of Air Photo-topography.

Institution of Electrical Engineers (Informal Meeting), at 7.—H. T. Young and others: Discussion on the Need for Co-operation between Electrical Manufacturers and Contractors.

Institution of Mechanical Engineers (Graduates' Section), at 7.—R. C. Bond: The Walschaert Locomotive Valve-gear.

Royal Institute of British Architects, at 8.—G. E. S. Streatfeild: The Hammersmith Housing Scheme.

Aristotelian Society (at University of London Club), at 8.—Miss H. D. Oakeley and others: Discussion on Prof. Wildon Carr's A Theory of Monads.

Royal Society of Arts, at 8.—J. E. Sears, jun.: Accurate Length Measurement (3) (Cantor Lecture).

Chemical Industry Club (at Whitehall Court), at 8.

TUESDAY, March 20.

Royal Institution of Great Britain, at 3.—Lecture: Diseases of the Prehistoric Britons.

Royal Society of Medicine, at 5.—General Meeting.

Royal College of Physicians of London, at 5.—Dr. A. J. Hall: Encephalitis Lethargica (Epidemic Encephalitis) (2) (Lumleian Lecture)

Royal Statistical Society, at 5.15.

Newcomen Society (at Prince Henry's Room, 17 Fleet Street), at 5.30.—D. Brownlie: The Early History of the Gas Process.

Institute of Transport (at Institution of Electrical Engineers), at 5.30.—Lecture on Town-planning and Re-modelling in Relation to Traffic.

Zoological Society of London, at 5.30.—Sushil Ch. Sarkar: A Comparative Study of the Buccal Glands and Teeth of Opisthoglyph Snakes, and a Discussion on the Evolution of the Order from Aglypha.—O. Thomas and M. A. C. Hinton: The Mammals obtained in Darfur by the Lynes-Lowe Expedition.—R. I. Pocock: (1) The External Characters of Elaphurus, Hydropotes, Pudu, and other Cervidæ; (2) The Classification of the Sciuridæ.

Institution of Civil Engineers, at 6.

Institute of Marine Engineers, Inc., at 6.30.—J. Lamb: Operation of the Marine Diesel Engine—Cylinders and Pistons.

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—W. F. A. Ermen: The Preparation of Metol and its Homologues.

Medico-Legal Society (at Medical Society of London), at 8.30—Dr. H. A. Burridge and others: Discussion on State Effort to rescue Drug Victims, with special reference to the Dangerous Drugs Act.

WEDNESDAY, March 21.

Institution of Naval Architects (at Royal United Service Institution), at 11.—Sir Eustace T. d'Eyncourt and J. H. Narbeth: A Proposed Aircraft-carrying Mail Steamer.—Sir John E. Thornycroft and Lieut. Bremner: Coastal Motor Boats in War-time.—At 3.—A. C. F. Henderson: Remarks on Some of the Present-day Problems in the Design of Ships.

Women's Engineering Society (at 26 George Street, W.1), at 6.15.—Dr. R. S. Hutton: Scientific Studies of Manual Work (Motion Study and Vocational Training).

Royal Microscopical Society (Industrial Applications Section), at 7.—E. Hatschek: The Standard Methods of Ultra-microscopy.—Dr. A. C. Thaysen: The Destruction of Cotton and other Fabrics by Bacteria, and the Importance of the Microscope in the Study of this Destruction.

Royal Meteorological Society, at 7.30.—G. M. B. Dobson: The Characteristics of the Atmosphere up to 200 km., as obtained from Observations of Meteors.

Royal Society of Arts, at 8.—Dr. F. W. Edridge-Green: Some Curious Phenomena of Vision and their Practical Importance.

Entomological Society of London, at 8.

Royal Society of Medicine (Social Evening), at 9.—Dr. H. C. Cameron: The Mystery of Lord Byron's Lameness.

THURSDAY, March 22.

Institution of Naval Architects (at Royal United Service Institution), at 11.—The Hon. Sir Charles A. Parsons, S. S. Cook, and H. M. Duncan: Mechanical Gearing.—W. Le Roy Emmet: Electric Ship Propulsion. At 3.—G. S. Baker and W. C. S. Wigley: Model Screw Propeller Experiments with Mercantile Ship Forms. At 8.—K. C. Barnaby: The Powering of Motor Ships.

Royal Institution of Great Britain, at 3.—Lt.-Col. E. F. Strange: Japanese and Chinese Lacquer (2).

Royal Society, at 4.30.—G. Hewett: The Dusuns of British North Borneo.—L. T. Hogben and F. R. Winton: The Pigmentary Effector System. III. Colour Response in the Hypophysectomised Frog.—H. R. Hewer: Studies on Amphibian Colour Change.—J. Walton: On Rhexoxylon, Bancroft. A Triassic Genus of Plants exhibiting a Liane-type of Vascular Organisation.—Margaret Tribe: The Development of the Hepatic Venous System and the Postcaval Vein in the Marsupialia.—J. Gray: The Mechanism of Ciliary Movement. III. The Effect of Temperature.—E. Ponder: The Inhibitory Effect of Blood Serum on Hæmolysis.

Royal College of Physicians of London, at 5.—Dr. A. J. Hall: Encephalitis Lethargica (Epidemic Encephalitis) (3) (Lumleian Lecture).

Fellowship of Medicine (at Royal Society of Medicine), at 5.30.—Dr. H. W. Barber: The Investigation of certain Diseases of the Skin in the Light of Recent Research.

Child-Study Society (at Royal Sanitary Institute), at 6.—Dr. H. C. Miller: The New Discipline.

Optical Society (at Imperial College of Science and Technology), at 7.30.—Dr. L. C. Martin: Surveying and Nautical Instruments from an Historical Standpoint.

Camera Club, at 8.15.—T. Bell: Portraiture.

Royal Society of Medicine (Urology Section), at 8.30.—S. Joly: Diverticulum of the Bladder with special reference to Operative Treatment.

FRIDAY, March 23.

Institution of Naval Architects (at Royal United Service Institution), at 11.—Prof. T. B. Abell: The Behaviour of Stiffened Thin Plating under Water Pressure.—Dr. J. Montgomerie: Further Experiments on Large-size Riveted Joints.—J. Anderson: The Influence of Form upon the Stability and Propulsion of Passenger Ships.—At 3.—W. Thomson: The Effect of Variations in Loading on Longitudinal Structural Stresses in Ships.—E. V. Telfer: Graphical Trim Calculation and a Trim Nomogram.

Association of Economic Biologists (in Botany Theatre, Imperial College of Science and Technology), at 2.30.—Prof. J. H. Priestley: The Causal Anatomy of the Potato Tuber.—E. H. Richards: Cellulose Decomposition: its Control and Applications.

Physical Society of London (at Imperial College of Science and Technology), at 5.—Dr. W. J. H. Moll: A Moving-coil Galvanometer of Rapid Indication.—Dr. W. J. H. Moll: A Thermopile for measuring Radiation.—Capt. C. W. Hume: Aberration and the Doppler Effect on the Theory of Relativity;—and the following Experimental Demonstrations:—C. R. Darling and the Hon. F. W. Stopford: The Production of E.M.F.'s by Heating Junctions of Single Metals.—R. H. Humphry: The Double Refraction due to Motion in a Vanadium Pentoxide Sol, and some Applications.

Junior Institution of Engineers, at 7.30.—R. J. Siddall: History and Development of the Underground Railway.

Royal Photographic Society of Great Britain, at 8.—F. G. Newmarch: A Tramp through Corsica.

Royal Institution of Great Britain, at 9.—Sir Ernest Rutherford: Life History of an Alpha Particle from Radium.

SATURDAY, March 24.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (6).

British Psychological Society (at King's College), at 3.15.—Miss Mary Sturt: The Estimate of Duration.

PUBLIC LECTURES.

SATURDAY, March 17.

Horniman Museum (Forest Hill), at 3.30.—Dr. A. Abram: Travelling in the Middle Ages.

TUESDAY, March 20.

School of Oriental Studies, at 5.—Sheikh Abd el Razek: The Study in Europe of Moslem Civilisation.

WEDNESDAY, March 21.

Royal Institute of British Architects, at 5.—Lord Sumner of Ibstone: The Public and the Architect.

SATURDAY, March 24.

Horniman Museum (Forest Hill), at 3.30.—Dr. W. A. Cunnington: The Natural History of Lobsters and Prawns.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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Labour and Science in Industry.

THE statement issued by the Trade Union Congress on February 19 entitled "The Attack on Labour Standards" calls for notice from those interested in the scientific organisation of industry. It is stated quite truly that "During the last 150 years industrial conditions have been revolutionised. Labour-saving devices have been introduced: steam and electric power have been developed, and the increased productive capacity of industry following innumerable inventions and scientific discoveries has enabled those who work by hand and brain to increase enormously their output." But if this increase in mechanical power is to be labour-saving, it must not, they go on to say, be at the expense of those who labour, and they have some fear that an attempt is being made "to utilise the present 'slump' for the purpose of degrading conditions of employment to the lowest possible point." In particular it is claimed that a reduction in the hours of labour is the only means of enabling the workers to share in the triumphs of civilisation and industrial peace, and that a firm front must be maintained on that point.

It would be impossible in a short article, and unsuitable in these columns, to enter on a discussion of the detailed questions involved in various industries at the present day; but the general question is one of the highest moment. Seeing that the application of science to industry has transformed society in the period referred to, and has indirectly affected politics, art, education—in fact every side of Western life—it behoves us to consider with the utmost care how far the mass of the workers has benefited by the change. By this it must ultimately be judged, for whatever may be the eternal value or eternal permanence of knowledge in itself, as soon as we apply it to the conditions of our life, it must be judged by the effects on the whole people and not on the few. As a human being, enjoying the products of industry, the happiness of the manual worker has an absolutely equal claim to moral or legal consideration with that of those who direct or organise his work.

This will scarcely be questioned nowadays on the employing side. Are not the "workers" on their side now ready to agree that, so far as we can judge in so difficult a matter, since the Trade Union action and legislation of the last three-quarters of a century, the conditions of the working-class are both happier, more intelligent, and more humane than they were before Watt invented the steam-engine?

But, it will be said, is not the betterment, if real, due not to science, but to legislation and other action necessitated by the evils which the industrial revolution had produced? Above all, have the "workers" received a fair share in the increased products?

On the latter point a decision commanding universal assent is impossible. There is no absolute standard of justice in such affairs. If we can be satisfied on the general question, that the condition of the workers has been appreciably improved by the applications of science to industry and life, it would be unreasonable to seek a mathematical proportion. Can we? Immediately after the introduction of big machines and factory production, we certainly could not. The herding together of crowds of poor people in hideous, hastily constructed, and insanitary town-dwellings was a monstrous evil. Even now these conditions too largely persist to allow a very roseate picture to be drawn. But, on the other hand, so much has been done to ameliorate them that it would be equally untrue to paint quite so black a picture as may be heard described from Labour platforms. Life has been transferred from country to town for the mass of our people, and that has its inevitable drawbacks. But it is not on the whole an unhappy or degraded life. Houses have been, and are being, vastly improved. Hours of labour have been reduced, and there is not the slightest prospect of their return to the condition of the early factory years. Facilities for education and enjoyment have been vastly increased, or rather newly created. Health is remarkably improved.

One result of the change in industry due to science is seldom noted in these discussions, and yet it is one of the most important. Mass production and scientific machinery have between them thrown up a large new class of men intermediate between the manual workers and the capitalist director. This class—the foreman, the shop-steward, the manager, the man with exceptional organising or mechanical ability who invents and sets up on his own account—is the most characteristic human product of the industrial revolution and one of the weightiest factors in modern society. Those estimating the share taken by "Labour" in the fruits of scientific industry cannot omit this, which is the best paid section and nearest to the mainspring. Moreover, in general we may note that those industries which have absorbed most brains in their development, notably engineering, also pay the highest wages. Agriculture, which has up to the present remained most primitive, pays the lowest.

The application of science to industry does not appear, therefore, to carry with it the wholesale degradation of the working-class as is sometimes contended, though the great mass who do purely mechanical work are rightly the chief concern of the social reformers and the Trade Union Congress.

F. S. M.

An Antarctic Saga.

The Worst Journey in the World: Antarctic, 1910–1913. By Apsley Cherry-Garrard. (In 2 vols.) Vol. 1. Pp. lxiv + 300 + 4 + 30 plates + 4 maps. Vol. 2. Pp. viii + 301–585 + 28 plates + 1 map. (London, Bombay, and Sydney: Constable and Co., Ltd., 1922.) 63*s*. net.

THIS is the sixth book to give the story, or part of the story, of Capt. Scott's last expedition, and it is in some ways the most remarkable of them all. Mr. Cherry-Garrard took part in three of the worst journeys ever made in the Antarctic or anywhere else, and the iron of his sufferings has entered into his soul and imparted a ferric quality to his recollections. He writes often with a forceful epigrammatic directness that makes one gasp; again he falls back into pages of rather heavy going, for his quotations from the other books on the expedition are very numerous, albeit they are well chosen. The very first paragraph of the preface sets the keynote of simulated cynicism and paradox.

"This post-war business is inartistic, for it is seldom that any one does anything well for the sake of doing it well; and it is un-Christian, if you value Christianity, for men are out to hurt and not to help—can you wonder when the Ten Commandments were hurled straight from the pulpit through good stained glass. It is all very interesting and uncomfortable, and it has been a great relief to wander back in one's thoughts and correspondence and personal dealings to an age in geological time, so many hundred years ago, when we were artistic Christians, doing our jobs as well as we were able just because we wished to do them well, helping one another with all our strength, and (I speak with personal humility) living a life of co-operation in the face of hardships and dangers which has seldom been surpassed."

This prepares us for the last sentence in the preface, which in turn illuminates the literary landscape of these volumes:

"My own writing is my own despair, but it is better than it was, and this is directly due to Mr. and Mrs. Bernard Shaw. At the age of thirty-five I am delighted to acknowledge that my education has at last begun."

An author possessed of so humble and hopeful a disposition should not take it amiss if a critic tries to help by suggestions of improvement as well as by hearty recognition of exceptional candour and artistic power.

To begin with, the historical introduction detracts from the value of the book, of which it occupies sixty-four pages. It ought to have been much shorter and focussed more directly on McMurdo Sound. Unfortunately, Mr. Cherry-Garrard went direct to Cook's "Second Voyage" and neglected to check his extracts in proof, otherwise he would not speak of "*sus*pissated juice," nor would he have quoted a longitude as "2° East" without adding Cook's essential words "of the Cape of Good Hope." On the other hand, he omitted to consult the *Challenger* "Narrative," but took from some uncited source the surprising statement that the *Challenger* "spent three weeks within the Antarctic Circle," the actual time having been more nearly three hours. Later history as summarised by Mr. Cherry-Garrard also requires revision. Borchgrevink should have been mentioned as the first man to land on the Ice Barrier and travel over its surface, and Armitage might have been named as the leader of the first party to ascend to and travel over the great polar Plateau.

Incidentally, the paging of the book reveals the fact that it was designed as one volume, for vol. 2 begins with p. 301, and as the exigencies of printing made it difficult to end vol. 1 on p. 300 four unnumbered pages had to be introduced, and so a singularly clear description of the embryology of the Emperor penguin by Prof. Cossar Ewart, which occupies those pages, has necessarily escaped the index.

As a general account of Scott's last expedition Mr. Cherry-Garrard's book surpasses all the others. Mr. Priestley's book on the northern party, Dr. Griffith Taylor's and Mr. Ponting's on the main wintering party, and Capt. Evans's account of his personal experiences are fine books, each in its way dealing admirably with special aspects but leaving the expedition as a whole unchronicled. The two great volumes of Scott's Last Journey giving the official account omit the preliminary arrangements for the expedition, of which Mr. Cherry-Garrard gives a racy account, and enter too fully into the fears and anxieties of the leader on the great southern journey to leave a clear impression on the mind. Again, the exquisite reproductions of Dr. Wilson's beautiful water-colours and the panoramic sketches of scenery give to the volumes before us a charm that in large part compensates for the very high price which their inclusion necessitates.

If poetry be indeed definable as "emotion recollected in tranquillity," Mr. Cherry-Garrard has given us a true epic of exploration. His emotion was strong and his recollection is sardonically calm. The description of the "worst journey in the world" from Cape Evans to Cape Crozier in winter darkness to obtain eggs of the Emperor penguin is the most vivid and moving we have met with in polar annals. The mellow nobility of Wilson's character and the dauntless cheeriness and resourcefulness of Bowers made them ideal companions in a desperate adventure, and despite the deprecatory references to himself we can see that Mr. Cherry-Garrard was not unworthy of his associates. To be sure, Bowers would not have worried if all the penguin eggs had been broken, nor would Wilson have taken offence at the superior aloofness (real or imaginary) of a museum official, which hurt the author severely. All the same, we think the Gilbertian humour and grotesque exaggeration of Mr. Cherry-Garrard's efforts to extort from the "Chief Custodian" an expression of the value of the objects for which three men had put their lives to the touch may well be passed by as a piece of friendly banter, for to the general reader it serves as an artistic relief to the grim horror of the quest.

The description of the main southern journey and of the ascent and descent of the Beardmore Glacier is a most valuable piece of first-hand narrative. Still more must one appreciate the story of the return of the last supporting party under Capt. Evans, which is told in large part in the very words of Lashley, one of the two "naval ratings" who saved the life of their leader by heroism as fine as ever was. The diary, given in its original lower-deck language, is a masterpiece of rugged prose that defies all rules of grammar and is incapable of imitation.

Mr. Cherry-Garrard conveys a good impression of the scientific aims of the expedition in untechnical words; but in our opinion the real value of the book is as a contribution to polar psychology. Priestley has treated of this aspect of the expedition more formally; but here we have a quarry of the raw material with which psychologists will know how to deal. As a rule, official reports fail in a candid treatment of the human element in an expedition, while the unauthorised records of subordinates usually fail in trustworthiness. Yet we know more of the mental state of Cook's companions in 1773-75 from Forster's ill-natured volumes than from the great navigator's own calm narrative, and we get delightful sidelights on Sir James Ross from M'Cormick's "Polar Voyages" in spite of the conceit and short-sightedness of the writer. We cannot view Mr. Cherry-Garrard's analyses of the character of his leader or his comrades as ill-natured, while he is certainly totally free from any suggestion of claiming superiority for himself, and, save in the case of the "Chief Custodian" referred to above, he is obviously sincere.

To future students of polar travelling this book will prove invaluable whether all the opinions put forward in it are accepted or not. We are reluctant to raise controversies that would no longer serve a practical purpose; but no future explorer can afford to pass by the criticism of the rations used for sledge-travelling or the inquiry into the real cause of the collapse of Scott's party. While the immediate cause was, as Scott stated, the shortage of paraffin for heating and the totally unexpected low temperature of the air on the Barrier surface in March, Mr. Cherry-Garrard indicates that an unfortunate dietary had led to the slow and gradual undermining of the health of all the members, lowering their vitality to a point which made the struggle hopeless. The discussion of this subject is painful; but it is scarcely likely that the views put forward will be accepted by the survivors of this or other polar expeditions without very careful scrutiny. It must be remembered that only experience can test the sufficiency of any diet, and that the best theoretical views are open to revision in the light of new knowledge. The War included so many large-scale experiments on mal-nutrition that any one criticising Scott or his advisers for their views in 1909 must be careful to do so with respect only to the state of knowledge at that time.

Capt. Scott was a great leader, and it may be that the wave of hero-worship which rose to so unprecedented a height when the news of his fate became known overshadowed the merely human side of his character. Even if all that Mr. Cherry-Garrard says of the strength and of the weakness of his late leader stands the test of time, the question cannot but arise whether the time for such a characterisation has yet come. In the future it will be a valuable piece of comparative study to contrast one great leader with another, but it will never be fair to compare the searching analysis of Capt. Scott with the more conventional presentment of other leaders whose qualities have been dealt with, let us say, with the reticence dictated by Victorian standards of consideration for the feelings of surviving relatives.

We think that it may be possible to combine fearlessness with good taste by placing on record in some safe keeping for future study the most intimate personal criticism of explorers by those who have been most closely in contact with them; and we should like to see all personal diaries of all the expeditions secured from the risk of destruction, especially from the risk of destruction by the writers themselves in after years, by deposit with a responsible institution in trust for posterity.

HUGH ROBERT MILL.

Indian Irrigation.

Triennial Review of Irrigation in India, 1918–1921. Public Works Department of the Government of India. Pp. v+222. (Calcutta: Government Printing Office.) 5 rupees.

INDIA is a land of many problems, and not the least difficult and perplexing is that of irrigation. The meteorological conditions vary there more than anywhere else in the world, within an equivalent area. The country contains alike the locality (Cherrapunji) with the greatest recorded average annual rainfall (460 inches) and arid tracts where rain is practically unknown. More troublesome than these extremes is the general irregularity of the incidence of precipitation, its unequal distribution, its capricious periodicity, its liability to entire failure. Drought and famine are ugly visitants to a country, but they are only too familiar to the unfortunate inhabitants of the land of the Moguls.

There is no need, therefore, to enter any plea or make any justification for irrigation works in India. Not merely the happiness and comfort but the very existence of many thousands of lives depends upon the provision of supplies of water by artificial means to the crops during the dry season.

The volume before us contains a record of the irrigation works carried out during the triennium 1918–21 by the Public Works Department of the Government of India. It also embodies an extremely interesting review of the inception and progress of various undertakings of the kind during a period of some forty years. The 10½ million acres irrigated by Government Works in 1878–79 have grown to 28 million acres in 1919–20. Perhaps a better method of forming an idea of the works themselves is to speak in terms of channels constructed. By the year 1900–1 there were 39,142 miles of Government channel in operation. In 1920–21 this length had increased to 55,202 miles. Every year there has been an average addition of 800 miles.

From an agricultural point of view, the triennium 1918–21 consisted of a central prosperous year between two lean years. In the first year the average deficiency in the rainfall throughout the plains was greater than in any preceding year since 1877. In 1919, on the other hand, the precipitation for the whole season was 5 per cent. above the normal. In the following year another set-back occurred, and the percentage below the normal ranged from 13 in the United Provinces to no less than 83 in Sind. Commenting on these facts and their relationship to the irrigation works already in existence, the report truly says: "But for the works, on millions of acres the crops would never have come to maturity; on millions more, no crops at all could have been sown. . . . It is safe to say that even 20 years ago, many tracts would have suffered from widespread famine which, owing to the facilities now afforded for irrigation, passed through the triennium unscathed."

The review of the triennium period includes a notice of the great Triple Canals project in the Punjab, commenced in 1905 and finally completed in 1917. It consists of 433 miles of main canals and branches and 3010 miles of distributaries, in connexion with which nearly 20,000 miles of watercourses have also been constructed. The total area commanded is 6250 square miles, and it is proposed that 1,675,000 acres shall be irrigated annually. Another notable undertaking referred to is the Divi Island project in the delta of the Kistna river in Madras, which is an attempt to effect irrigation on a large scale by pumping. The installation comprises eight double-cylinder Diesel engines, each of 160 h.p. and driving a centrifugal pump capable of discharging 73 cu. ft. per second on a 12-foot lift. Another engine is to be added shortly.

Among the works now in hand is the Sarda Canal in the United Provinces. The decision to construct this canal finally settles what has probably been the most contentious question in the irrigation of India. The controversy over the matter has lasted for more than half a century. The canal when constructed will irrigate the North-Western districts of Oudh. It will comprise 478 miles of main canals and branches and 3370 miles of distributaries.

Space does not admit of reference to other interesting schemes which are described in the report. Its 222 pages are replete with useful information, which will repay study by those interested in the subject. There is a helpful series of maps and diagrams, many excellent photographs, and some tabular statements showing the financial results of the various irrigation operations throughout India.

BRYSSON CUNNINGHAM.

Scientific Societies in the British Isles.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature, and Art during the Session 1921–22 by numerous Societies and Government Institutions. Compiled from Official Sources. Thirty-ninth Annual Issue. Pp. vii + 374. (London: C. Griffin and Co., Ltd., 1922.) 15*s*. net.

THE appearance once more of Messrs. Charles Griffin's well-known Year-Book affords us an excellent opportunity for taking stock of the position of science in the British Isles. The volume is arranged in the customary style, the various bodies dealt with being divided among fourteen sections according to the nature of their activities. In each section again, there is a further grouping according to the location of the society, institution, or department in London, the Provinces, Scotland, or Ireland. As is only to be expected, most of the more important entries appear in the London groups. In each case, some particulars of the society or institution are given, together with a list of its publications during the year when available.

The total number of societies, research departments, etc., appearing in the 1922 Year-Book exceeds 550, of which it is fair to say that some 480 are concerned, directly or indirectly, with science. The remaining 70 are accounted for by literature, history, and law. In addition to these, there are long lists of local societies and clubs interested in photography, law, or medicine. The distribution of the societies among the various sections is also interesting. Section 1, including bodies dealing with all branches of science, has 75 entries; sections 5 and 7, covering biology and mechanical science respectively, have 90 each; section 13, on archæology, has 63, while section 14, on medicine, has 54 entries apart from the long list of local medical societies.

The various societies and bodies of a similar nature appearing in the Year-Book can be divided fairly sharply into two distinct groups; those which exist for the publication of research, and those which are better described as functioning for the popularisation and spread of knowledge. Of the five hundred or so entries appearing, about one hundred seem to fall into the former group; and of these 14, including the Geological Surveys, the National Physical Laboratory and the Royal Observatory at Greenwich, are supported by Government.

A mass of similarly interesting information exists in this valuable publication, and it may seem ungracious to ask for more. That is, however, the penalty of providing good fare. The sub-title of the volume states that it deals with the year 1921–22, but, for example, it is somewhat late in the day to find information on the British Association brought up only to the Edinburgh meeting of 1921. Further, we would suggest the inclusion of the numerous Research Associations now in existence, while it would add much to the interest of the volume if the number of members of each society could be indicated. A few errors in classifying the entries have been noticed; for example, the Nature-Study Society and the School Nature-Study Union appear in the section headed Psychology. These are, however, minor blemishes in a most valuable publication, which we believe is the only single volume providing an outline survey of the activities of most, if not all, the learned societies of the British Isles.

Aluminium and its Alloys.

(1) *Aluminium and its Alloys.* By Lieut.-Col. C. Grard. Translated by C. M. Phillips and H. W. L. Phillips. Pp. xxiii + 184 + 16 plates. (London: Constable and Co., 1921.) 17*s*. 6*d*. net.

(2) *The Institution of Mechanical Engineers: Eleventh Report to the Alloys Research Committee: on Some Alloys of Aluminium (Light Alloys).* By Dr. W. Rosenhain, S. L. Archbutt, and Dr. D. Hanson. Pp. ii + 256 + 24 plates. (London: Institution of Mechanical Engineers, 1921.) 42*s*.

(1) LIEUT.-COL. GRARD'S book is essentially a treatise on the mechanical properties of aluminium and some of its commercial alloys. The extraction of the metal is described in two pages, and no more detail is given than in an elementary textbook,

although there are several plates showing the power houses of Continental works. The account of the economic position of the industry is also too meagre to be of much use. The valuable part of the book consists of a long series of diagrams of mechanical properties of metal that has been subjected to various thermal and mechanical treatments, and of a corresponding series for certain of the light alloys and for the aluminium bronzes. Tensile strengths are given in metric and British units—an excellent practice.

The lack of any theoretical discussion deprives these sections of much of their value. The ageing of duralumin and similar alloys is a puzzling phenomenon when presented in the form of a mere record of tensile and hardness tests, but becomes comprehensible when considered in the light of microscopical and electrical evidence, and interpreted by means of the theory of solid solutions. Most of the photomicrographs represent the copper-aluminium alloys, commonly called aluminium bronzes. The writer appears to be unaware of the work that has been done in this country, at the National Physical Laboratory and at the Royal School of Mines, which has thrown so much light on the properties of this metal and of the light alloys. The book will be found useful chiefly for reference, when information is sought as to the strength, hardness, cupping quality, etc., of the alloys with which it deals.

(2) The latest report of the Alloys Research Committee is of a very different standard. The recent work carried out at the National Physical Laboratory has led to the preparation of several new alloys of technical importance, the most remarkable being the alloy "Y," which retains its strength and resistance to alternating stresses at elevated temperatures, and is also resistant to corrosion. This alloy contains copper, nickel, and magnesium. The report includes studies of the constitutional diagrams of several of the binary and ternary systems, and an investigation of the causes of age-hardening in aluminium alloys. In this connexion the importance of magnesium silicide as a hardening agent is shown, and the changes of hardness with time and temperature are correlated with the changes in solubility of this compound in the solid solution. The principal casting alloys are found, from measurements extending over long periods, to be stable in dimensions, and there is no doubt that these researches have added to the range of structural materials of high quality available to the engineer, and that a great future lies before light alloys, suitably heat-treated. The photo-micrographs illustrating the volume are remarkably clear, and their beauty will be appreciated by all who have had occasion to prepare these alloys for examination. C. H. D.

Our Bookshelf.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. E. Abderhalden. Abt. V: Methoden zum Studium der Funktionen der einzelnen Organe des tierischen Organismus. Teil 3A, Heft 3, Lieferung 69: Entwicklungsmechanik. Pp. 441–538. 630 marks. Abt. IX: Methoden zur Erforschung der Leistung des tierischen Organismus. Teil 1, Heft 2, Lieferung 71: Allgemeine Methoden. Zoologische allgemeine Methoden. Pp. 97–438. 2160 marks. (Berlin und Wien: Urban und Schwarzenberg, 1922.)

THE number of subjects included in these two parts of Abderhalden's great "Handbuch" precludes, in a short notice such as the present, anything beyond a mention of the chief topics discussed.

Lieferung 69 is devoted to "Entwicklungsmechanik." Here Herbst discusses methods of artificial parthenogenesis; Günther Hertwig, the method of irradiation of the germ-cells by radium and Röntgen rays; Romeis, the technique of investigations on the action of organic extracts, such as muscle, thyroid, and suprarenal extracts, on invertebrates, anuran tadpoles and urodele larvæ; and Braus, the methods of tissue cultures *in vitro*.

Lieferung 71 is more extensive. Przibram is responsible for a chapter of about 90 pages on "Living Material for Biological Investigations." In this he considers the choice of species to be employed in biochemical researches, how and whence to obtain them, their transport and maintenance, the terrarium, the aquarium (including the setting up and aeration of seawater aquaria), and the insectarium. In addition, there is given some account of the application of chemical agencies, the means of obtaining and maintaining various degrees of moisture and of pressure, the application of mechanical agencies, and the alteration of the action of gravity. The subjection of the animals to the action of electricity and of magnetism, the application of heat and of light (measurement of the degrees of light, coloured light, ultra-red and ultra-violet rays), and the isolation and marking of the subjects of the experiments are also dealt with.

Two sections of 40 pages each are devoted to methods of preservation of zoological preparations and to zootomical technique. The methods of reconstruction by means of wax or paper plates are fully explained, while shorter but useful sections deal with the preparation of simple text-figures by the author, and with the production of transparent museum preparations.

Oxidations and Reductions in the Animal Body. By Dr. H. D. Dakin. Second edition. (Monographs on Biochemistry.) Pp. ix+176. (London: Longmans, Green and Co., 1922.) 6*s*. net.

THE complex chemical compounds taken as food by animals are not brought by a single reaction of oxidation to their final states of water, carbon dioxide, and urea. They pass through many intermediate stages, which are of great interest and importance, not only from the purely chemical aspect, but also on account of the fact that many of them play a part in the production of substances which have a profound influence on physiological processes. It is the object of Dr. Dakin's monograph to describe these intermediate stages, and the reader may be satisfied that he will obtain the latest information on the subject. The book is to be highly recommended. It has a good index and a complete bibliography. The section on carbohydrates has been almost entirely rewritten since the previous edition. The description of oxidations which can proceed with the aid of water without free oxygen is of interest in itself, but such processes are of subsidiary importance in the higher animals, since these cannot exist without free oxygen.

With reference to certain views held as to the significance of catalase, the author concludes that there is no evidence that this enzyme has any connexion with oxidation; it may, however, be of use in decomposing excess of hydrogen peroxide, produced in the course of autoxidation, into inactive oxygen. The author points out that he is not concerned with the thermodynamics of the various reactions, nor with the catalytic mechanisms by which they are brought about, although he devotes a few pages to autoxidation and the peroxide systems, and to the important glutathione system of Hopkins. This omission is not to be regarded as a serious defect, because the object of the monograph is of a different kind. It reminds us, however, that there is an urgent need for a monograph dealing with the thermodynamics and general physical chemistry of the oxidation mechanisms of the living organism. W. M. B.

A Treatise on the Integral Calculus: with Applications, Examples, and Problems. By J. Edwards. Vol. 2. Pp. xv+980. (London: Macmillan and Co. Ltd., 1922.) 50*s*. net.

IN the second volume of his large treatise on the integral calculus, Mr. Edwards deals with multiple integrals, gamma functions, Dirichlet integrals, definite integrals in general, contour integration, elliptic functions, the calculus of variations, Fourier series and integrals, mean values and probability, and the harmonic analysis. The volume contains an immense collection of formulæ and questions extracted from examination papers and from the older literature of the subject, which may prove useful for reference to the sophisticated reader, but are more likely to repel than to inspire the students for whom the book appears to be intended.

Mr. Edwards is confessedly out of sympathy with modern tendencies in mathematical education, and thinks that students do not learn enough skill in manipulation. He prefers that they should devote their energies to acquiring proficiency in methods which are in many cases obsolete, rather than that they should obtain the same results by a systematic application of a few powerful general theorems. This tendency is particularly obvious in the chapters on definite integrals and on elliptic functions. In consequence, that residuum of problems for which the older methods are still the most suitable receives rather less than justice. His use of the methods of differentiation and integration under the integral sign, change of the order of integration, etc., is uncritical, and is not likely to conduce to clear thinking on these important subjects. His definition of a function of a complex variable is unsatisfactory, and entirely misses the point in failing to emphasise the crucial importance of the existence of a unique derivative. In the bibliography of the chapters on the calculus of variations he refers the reader to a number of obsolete treatises, but ignores the important modern works of Hadamard and Kneser.

The teacher of to-day may use this work for reference himself, but he will scarcely wish his pupils to make their first acquaintance with the processes of analysis from its pages. E. G. C. POOLE.

Farm Buildings. By W. A. Foster and Deane G. Carter. (Agricultural Engineering Series.) Pp. xv+377. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 15*s*. net.

THE little work under notice is intended to guide the American farmer and agricultural student in designing and constructing farm buildings. It is stated that farm buildings have had their most rapid development in America in the years since 1910. Prior to that one could, and indeed still can, find the early buildings put up by the first settlers, made of logs, if trees were abundant, or of sods or boards if they were not, as happened on the prairies. Now, however, these rough constructions have largely disappeared, or remain only as stores of subsidiary importance, and their place is taken by large new and characteristic-looking structures of steel and concrete. The change is not only one of convenience: it represents a great saving on the farm. It is estimated that at least 100,000,000 dollars is lost annually to American farmers through depreciation of farm machinery due to lack of proper housing; that 200,000,000 dollars are lost annually owing to the consumption of badly stored food by rats; and further, that considerable increases in milk and meat production could be obtained if the animals were better housed.

The authors discuss the best types of barns, stables, cowsheds, pigstyes, etc., and give many illustrations showing how to adapt the design to the available situation or space, and what materials should be used in construction.

The English agricultural student will find the volume of particular interest for its sections on silos, pigstyes, and cattle-sheds, and for a fund of information showing how the American farmer, suffering from even greater shortage of labour than his British confrère, has nevertheless succeeded in putting up buildings of undoubted utility.

British North Borneo: An Account of its History, Resources and Native Tribes. By Owen Rutter. Pp. xvi+404+plates. (London, Bombay, and Sydney: Constable and Co., Ltd., 1922.) 21*s*. net.

ALTHOUGH Sir West Ridgeway, the chairman of the British North Borneo Company, contributes a preface to this volume, it is in no sense an official publication. This will be appreciated by those who are conversant with recent criticisms of the company's methods of administration. The author is both fair and unbiassed.

The story of North Borneo is not without stirring incident. In the last century its coast was infested with pirates, whose extermination was first undertaken seriously in 1845 at the instigation of Rajah Brooke of Sarawak. Their subjugation was completed only in 1879, the year the British North Borneo Company was formed. Of the numerous native risings with which the company has had to deal, the most formidable was that headed by the redoubtable Mat Saleh, who was defeated and killed in 1899.

Mr. Rutter gives a very complete account of the geography and economic resources of the country, of which, however, the greater part is still undeveloped. The native population offers many points of interest to the ethnologist. The Dusuns and Muruts, the up-country agricultural population, are of Indonesian stock. The coastal peoples, Bajau, Illanun, and others, represent an incursion of Malayan stock. The latter are Mahommedans, while the former are pagan. A remarkable feature in the religious beliefs of some of the Dusuns is the cult of the sacred jar, in each of which a small company of relatives has a joint ownership.

Incandescent Lighting. By S. I. Levy. (Pitman's Common Commodities and Industries.) Pp. x+129. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 3*s*. net.

THE author has produced an interesting and well-written book which gives a good historical account of the development of artificial lighting; particular attention being given to incandescent lighting. A chapter is devoted to the growth of the rare earth industry. The dramatic discovery of rich deposits of monazite in the British Empire, and notably at Travancore in India during the War, was a great help to this country; the sands at Travancore contain more than 45 per cent. of monazite. The processes of extracting pure thorium compounds from monazite demand great ingenuity, and they are well described. Descriptions are also given of the recent great improvements in the manufacture of incandescent mantles. The author gives a very fair comparison of the costs of oil, gas, and electric methods of lighting. The average candle-power (formerly called the mean spherical candle-power) should, however, have been taken as the basis of the comparison and not the mean horizontal candle-power.

Lubrication and Lubricants: a Concise Treatment on the Theory and Practice of Lubrication; the Physical, Chemical, and Mechanical Properties and Testing of Liquid and Solid Lubricants; with Notes on Recent Developments and Examples from Practice; for Engineers, Chemists, and Students. By J. H. Hyde. (Pitman's Technical Primers.) Pp. x+114. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 2*s*. 6*d*. net.

ALTHOUGH very uneven, the little book under notice is interesting. The definitions are usually rather carelessly given, if at all. Thus, in the chemical section (which is not very satisfactory) neither the iodine nor the acetyl value is explained, although both are quoted. Langmuir's name is incorrectly spelt throughout the book. The chapter on recent developments is of interest, and deals among other matters with the variation of efficiency with temperature and the effect of adding vegetable to mineral oils. We have previously commented on the very ambitious titles of the small books in this series; the remark applies in the present volume, and any one who expects what he might from the title will be disappointed.

Molybdenum Ores. By Dr. R. H. Rastall. (Imperial Institute: Monographs on Mineral Resources with Special Reference to the British Empire.) Pp. ix+86. (London: J. Murray, 1922.) 5*s*. net.

THE molybdenum minerals, their origin and mining, are dealt with, and an account of the metallurgy of molybdenum is also included in this work. The account of the electrical treatment on p. 5 does not seem complete, as no mention is made of the furnace charge. The sections on the sources of supply appear to be exhaustive, nearly every reported occurrence of molybdenum being mentioned, together with the production, if any. The table on p. 12 indicates that the demands for the metal are limited; the production in 1918 was equivalent to about 800 metric tons of metal; that in 1921 was only 7 tons. The principal use is in the preparation of special steels; a lower amount of molybdenum will replace tungsten in a high-speed tool steel, and a small amount of molybdenum is said to improve a mild structural steel.

History of Chemistry. By Dr. F. P. Venable. Pp. vii+169. (London and Sydney: D. C. Heath and Co., 1922.) 5*s*. net.

DR. VENABLE'S "History of Chemistry" is a second edition of a book that appeared in 1894. A history of chemistry which contains no illustrations or diagrams, and in which formulæ are used only in the few passages where their historical development is under consideration, must be subject to serious limitations and in the nature of things cannot be much more than a sketch. It is not quite clear to the reviewer what type of reader will be attracted by such a sketch; but it is likely that the well-read student of chemistry will find some interest in this brief outline, and may be led by it to follow up the history of his science in some volume in which more details are given.

The Elements of Scientific Psychology. By Prof. Knight Dunlap. Pp. 368. (London: Henry Kimpton, 1922.) 18*s*. net.

THE author has here produced one of the best and most useful of the many text-books now available on psychology. He is a good experimentalist, and is thoroughly alive to the importance of a knowledge of physiology to the psychological student. He shows himself able at the same time to maintain a distinctively psychological point of view. The main faults of the book are that it attempts to cover too much ground, and that occasionally it presents, as text-book material, conclusions which require to be subjected to much further research.

Grundzüge einer Physioklimatologie der Festländer. Von Dr. Wilh. R. Eckardt. Pp. v+123. (Berlin: Gebrüder Borntraeger, 1922.) 4*s*. 6*d*.

DR. ECKARDT has produced a useful little book, which aims at giving an outline, according to the most recent investigations, of the distribution of temperature, pressure, and precipitation in the main land-masses. Particular attention is paid to Europe. There are a number of sketch maps and diagrams, and a short bibliography. The book gives in a convenient and authoritative way information that is not generally accessible in a collected form. It should prove very acceptable to students of geography.

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.]*

The Wegener Hypothesis of Continental Drift.

THE chief value of the discussion on the Wegener hypothesis is that it has given rise to a reconsideration of the problems presented by the configuration and relations of the major features of the earth's surface.

The elaborate structure of theory built up by Dr. Wegener, and so effectively criticised by Mr. Lake (see NATURE, February 17, p. 226), will have few, if any, thorough-going defenders in this country, but some of its leading features cannot be lightly dismissed. Mr. Crook (NATURE, February 24, p. 255) has recalled to our notice the suggestions put forward by Osmond Fisher, and later by W. R. Pickering, that the separation of the moon from the earth, which Sir George Darwin believed to have resulted from tidal action, took place in the region now occupied by the Pacific; that our satellite took with it three quarters of the earth's crust, and that the remaining quarter, from which our continents trace their descent, has since split up into fragments which have drifted apart over the heavier fluid magma below, leaving channels between them, the most important of which is now the Atlantic Ocean. Here we have an interesting approximation to certain of the assumptions of the Wegener hypothesis; but both Osmond Fisher and Pickering, it will be noticed, considered the separation of the continents to be the result of a general drift towards the Pacific. In this they differ from Wegener, who attributes it to a varying lag of the earth's crust relatively to its interior, so that one portion became separated from another.

If the former view is well founded there should be a certain amount of symmetry about an equatorial diameter drawn to the centre of the Pacific from its antipodes in Africa. It is therefore interesting to note that Prof. Sollas in a communication to the Geological Society in 1903 (Q.J.G.S., vol. 59, pp. 184-8) declares that "an axis of terrestrial symmetry" "passes through the middle of Africa on the one side, and the Pacific Ocean on the other," a depression in the Pacific corresponding to a dome in Africa. He is inclined to accept Osmond Fisher's hypothesis, that the Pacific owes its origin to the birth of the moon, and suggests that the African dome represented an unsuccessful attempt on the opposite side of the world to give birth to a second satellite. This symmetry is, it is true, obscured by the east and west folding, which is such a frequent feature in the earth's crust, and is attributed by Wegener to a drift away from the poles towards the equator, but is not improbably the result of a movement from the equatorial region to the poles due to the slowing down of the earth's rotation and consequent decrease of the ellipticity of its figure and of the equatorial protuberance.

Like Mr. Crook, Prof. Sollas follows Suess in believing that the Atlantic owes its origin not to continental movement but to the foundering of the tract which it now occupies. My principal object in writing is to point out that the hypothesis of the drifting apart of North and South America from Europe and Africa is quite consistent with that of a subsidence and submergence of a great part of the ocean area that now separates them; and that the latter is in fact the consequence of the former.

The evidence, based on similarity of lithological characters and fossil contents of the rocks, that South America east of the Andes and the Falkland Islands were once in much closer proximity to Africa, is to my mind conclusive, and scarcely less is that of a former association of a great part of India and of Australia with Africa. There seems, too, every reason to believe that, although masked in places by other tendencies, there has been a general movement of the lighter continental crust or Sial from Africa towards the Pacific. This appears to be a drift from a region of a comparatively low gravity to one of higher gravity.

As we have seen, Wegener and others believe that the earth's crust lags behind the solid core as a result of tidal retardation, and that this lag varies from point to point. If this is the case, the folded mountains that have their roots deep in the earth's interior will, no doubt, have a smaller lag than other portions of the earth's crust, and therefore, as Prof. Joly suggests, a relative movement from west to east. How far such movements are of importance it is at present impossible to say.

Whatever may be the ultimate causes of the relative movement of continents, they can only be effective when they operate in a direction in which the earth's crust does not possess sufficient rigidity to oppose them. We can no longer suppose that there is a fluid substratum to the earth's crust. It is probable that the solid crystallised zone below the oceans is usually fifteen to twenty miles in thickness, and at those depths the enormous pressure of 90 to 120 tons to the inch will give a comparatively high rigidity at the temperature of about 800° C. that may there prevail, even to an uncrystallised magma. Where, however, a great thickness of sediment has accumulated in the neighbourhood of a continent on a sea-bottom, it will—as Dana was the first to point out—by acting as a blanket, cause the temperature of the rocks beneath to rise and become less rigid, especially if they are basic in composition. In this rise of temperature, Prof. Joly believes radioactivity plays an important part. At the same time the area concerned will sink slowly to satisfy the requirements of isostasy, forming a trough parallel to the coast line. If a period of compression in a direction at right angles to the coast supervenes, the rocks will yield to it and the trough will be laterally compressed and deepened while the sedimentary accumulations are thrown into folds. In this way the land masses surrounding the Pacific have been enabled gradually to advance inwards from its circumference, their progress being marked by folded mountain ranges. Yet the Pacific, as a whole, apart from the marginal portions, being comparatively free from sedimentation, has preserved its rigidity and successfully resisted compression.

On the other hand, there seems reason to believe that Africa is in the main the centre of a region of tension, due to the outward drift of continental masses in the circumstances already described. It is obvious that the separation caused by such a movement must involve a deficiency of material in the separating tract, and a loss of stability on the margin of the separated masses. Sometimes the blocks into which they are divided by jointing will fall forward one upon another like a succession of bricks and so give rise to a number of faults dipping away from the rift. Examples of this are seen in Skye and Caithness. More usually the slow subcrustal movement towards the line of fracture will carry the solid crust with it. The result will be a series of faults hading towards the region of tension and with a downthrow in that direction. In North Devon and Cornwall I have shown that there is evidence that there has been a general debacle of the rocks towards the west in Tertiary times. North-west and south-east faults occur every few yards with a considerable hade to the south-west; but the slickensides show that the movement was oblique, partly down the fault planes and partly parallel to the strike of the faults to the north-west, the latter component being the more important, so that the total movement to the west must have been considerable. At the same time there has been a general tilt of the country in that direction. I am given to understand that somewhat similar faulting occurs in the South of Ireland, and, no doubt, it exists elsewhere on the eastern shores of the Atlantic. The total westward movement visible on the land does not amount to more than a few miles, but the downward displacement that accompanied it must have resulted in the submergence of a large area to the west, and the same structures, no doubt, extend still farther in that direction under the sea. In the actual neighbourhood of the rift (to use the convenient term employed by Prof. J. W. Gregory) there may well be a complete absence of the Sial, so that the Sima would be found close below the abysmal deposits of the deep sea, as Wegener supposed to be the case. There is, however, no reason to suppose that the opposite shores of the continents represent the actual margins of the rift, and we cannot expect to find the close correspondence between them which he endeavours unsuccessfully to demonstrate. Submarine plateaus rising in the midst of greater depths may represent portions of Sial submerged between two rifts.

The solution of these problems should be regarded as an urgent task for the immediate future. There is little doubt that further information with regard to the density of rocks below the sea-bottom would result from the systematic measurement of the variation of gravity at sea with concurrent determination of its depth. The new methods that are now available are at once more rapid and more trustworthy than those previously employed, and might well be carried out either by the Navy or the great ocean liners. Valuable information, too, will be yielded by the Eötvös balance with respect to the rocks below the sea in the immediate neighbourhood of the shore.

John W. Evans.

The Function of Mendelian Genes.

In Nature of March 3 there appears a letter from Mr. Julian Huxley on "The Function of Mendelian Genes," in which he criticises a paragraph in a review of mine published in Nature of January 20. As I think that the difference between Mr. Huxley and myself is due to a certain extent to a misunderstanding of my meaning, perhaps you will allow me space to make a brief reply.

Mr. Huxley's main point is that in treating Mendelian genes as measures of pathological damage to the hereditary substance, I forgot that each discovery of a presumably pathological mutant gene implied the existence of an allelomorphic normal gene in the type, and that in this way we were enabled to analyse the hereditary machinery of the type.

The paragraph to which Mr. Huxley alludes was a small item in a review devoted to vitalism. Mr. Huxley and I had a prolonged battle in *Science Progress* last year, and perhaps before long we may have another friendly encounter in the same journal. As he alludes to this contest in a footnote, I may here say that he is incorrect in stating that he forced me to admit that not all mutations were pathological. All I said was that I could not make such a universal statement without examining each case, but I may add that I have yet to meet with the Mendelian mutation which is not pathological. My answer to Mr. Huxley is that of course I recognise the existence of hypothetical allelomorphic normal genes, which taken together make up the hereditary machinery of the type, but I doubt the value of the analysis of this machinery into genes at all. The only analysis of the hereditary complex which seems to me to be at all interesting or fruitful, is its dissociation into the factors out of which it was actually historically built up. I regard this complex as the solidification, so to speak, of the reactions of the race to the varying experiences through which they have gone during past ages. New habits have been superposed on old ones, with accompanying modifications of structure; and when we have unravelled this history completely, we have given as exhaustive an account of the origin of the hereditary machinery as is possible.

The normal "gene" is an imaginary section of this machinery invented to account for the damage which a mutant gene introduces. Mr. Huxley alludes to the existence of multiple allelomorphs as *proving* that the recessive mutant gene is not the mere absence of something which we call the dominant gene. I think that a series of multiple allelomorphs inevitably suggests a graded series of varying degrees of damage, or, as we may phrase it, a series of increasing intensities of defect. Such a series is given by the mutants of the red eye of the wild Drosophila. These are listed as vermilion, scarlet, cherry, pink, eosin, cream, and white! What other plausible explanation can be given of these than the gradual disappearance of the dark red pigment of the normal eye?

One of the mutant genes of Drosophila produces a variation termed "balloon wing." In insects showing this variation the two layers of ectoderm forming the wing are widely divaricated from each other, the space between them being occupied by a bubble of air. Now there is a general consensus of opinion based on palæontology, embryology, and comparative anatomy as to the evolutionary history of insects' wings. They began as slight lateral extensions of the dorsal terga of the thorax, at first in all three segments; but later they were confined to the posterior two segments. In the beginning they served merely as parachute planes to break the fall of the insect when it leaped into the air; later, as they grew longer and flexible, they became capable of independent movement, and so developed into the varied types of wing found at the present day. On what phase, one may ask, of this history of progressive functional evolution does the existence of the balloon wing mutant throw the smallest light?

We are gradually learning to recognise that the body of an animal is built up by the co-operation of the semi-independent growths of a number of tissues and organs which, however, mutually limit and determine the extent of each other's growth. The compromise which is arrived at, is expressed in the normal specific or racial structure of the animal, and may be expressed by the term "regulatory balance." When the race is exposed to new surroundings, the regulatory balance is altered and a new race is evolved. This accounts for the fact noticed by Sturtevant that allied species differ from one another in numbers of minute points affecting all the organs of the body, whereas mutations are characterised by marked differences affecting only one or two organs. Mutations may be defined as pathological disturbances of this regulatory balance; if they are so severe as to produce a noticeable effect on the offspring when introduced by only one parent, they are dominant; if their effects are only apparent when both parents are affected, they are recessive.

Mr. Huxley's comparison of the mutant black mouse to the melanic local races of wild species is unfortunate. The black mouse (which I have often reared) is covered with a fur of so uniform colour as to make it exceptional among mammals. It may be compared to the various melanic sports which occur in other species of mammal, such as the black leopard. I have seen a black individual among a litter of the common Canadian squirrel.

On the other hand, a melanic local race implies a new regulatory balance. As an example of the relation of racial character to the environment, I may mention the common red grouse of Scotland, supposed to be the only species of bird peculiar to Britain. In Europe there is the allied species of willow grouse, differing in having the tips of the primaries white and in turning white in winter. When a Scotch landowner imported the willow grouse he found that in two or three generations they became indistinguishable from the red grouse; and when red grouse were introduced into Norway, they reverted in a few generations to a form indistinguishable from the willow grouse.

E. W. MacBride.

Zoological Department,
Imperial College of Science,
March 5.

Definitions and Laws of Motion in the "Principia."

In his recent interesting article (Nature, February 17) on the Definitions and Laws of Motion in the "Principia," Sir George Greenhill reopens a very old discussion (Nature, vol. 39, 1888-9). It might have been expected that the lapse of one-third of a century would have been sufficient for reconciliation of the engineer and the physicist. Every scientifically trained engineer knows, as Sir George Greenhill knows, that no confusion is introduced by the employment of a given multiplier or divisor in every term of an equation.

The only new feature now given in the mathematical discussion lies in his equation (1),

$$Wv/g = Ft,$$

in which it is insisted that the g as a divisor *must* be attached to the v and not to the W. But, in the weight problem, this merely makes the equation an identity with W = F; and, if we introduce F as a non-gravitational force, say by the use of a spring-balance, or a column of compressed air, etc., still giving t its old value, we find a different average F, and therefore a different W, at different localities. It is this local variation of W which reveals to the physicist an absence of that aspect of invariance, the existence of which he, as a scientific man, feels compelled to search for. And his search is not in vain; for he finds that, with v, t, and average or actual F (non-gravitational) all constant, W *is* proportional to g, and therefore the attachment of g to W is justified, in his belief, by Nature. In fact, he has come into contact with the *materiae vis insita*.

I have never known any student of engineering who, having first had a normal training in physics, felt compelled, in his engineering studies, to alter his ideas. He knows that his "factor of safety" in constructional details is large enough to cover such variations of g as he meets with in practice. The real quarrel (if it still exists) is only one regarding the use of the word "pound," and the context in the engineer's or the physicist's statement usually prevents confusion, even if it were not the case, as I have always found it to be, that the student of engineering is quite willing to speak, when clearness requires it, of the mass of a pound and the weight of a pound.

I do not agree with Sir George Greenhill that Mach was right in saying that Newton's Def. I. is only a definition of density. I regard it as presuming that the meaning of density is known, so that the definition is really one of the *quantitas materiae*, to which the *materiae vis insita* or *inertia massae* is proportional. It then implies the physical law that inertia is independent of the form of aggregation, and depends, for a specific material, only on the extent of the aggregation. Nor do I agree with him that Newton's use of many different words for the name of the same thing was undesirable. We must remember that Newton was the pioneer, introducing new ideas, and requiring therefore to use every form of phraseology or nomenclature that might help to make them understandable.

Sir George Greenhill disagrees with Tait, and credits him with the honour of introducing innovations. Now Tait was a modest man, and a loyalist towards Newton. He gives the honour to Newton, whose interpreter only he was. The further statements on this point made in Sir George Greenhill's second article do not alter the position.

Tait's wise words (*l.c.*) of a third of a century ago are well worth attending to to-day, apart from electrons. He said ". . . mass is the personal property of a body, one of the invariable things in nature:—and not an accidental property dependent, for its amount and even its very existence, on the momentary surroundings. The letter M has hitherto been used by Newtonians in this sense. If anyone has since attached to it another and different sense, *he* is responsible for the consequent confusion. Would it not be well if Prof. Greenhill, and the School to which he has attached himself, would kindly leave to Newtonians their M, as defined for them by their Master; and (with severely logical consistency) turn it upside down (thus, W) when they wish to embody their own revolutionary definition? No Newtonian will refuse to recognise $Wv^2/2g$ as a correct expression for so much energy:—though he will probably think it both clumsy and complex, and will prefer to write as usual his $Mv^2/2$."

W. Peddie.

University College, Dundee.

In his article under the above title in Nature of February 17, Sir George Greenhill expresses the opinion that it would be worth while to examine the previous state of the theory of dynamics to see what laws were current before the statement as given by Newton. The evidence of Newton on this point is often overlooked, though it is noted by Tait. In the scholium to Corollary VI. on the Third Law of Motion, Newton freely acknowledges the work of his predecessors.

"Hactenus principia tradidi a mathematicis recepta et experientia multiplici confirmata. Per leges duas primas et corollaria duo prima Galilaeus invenit descensum gravium esse in duplicata ratione temporis et motum projectilium fieri in parabola; conspirante experientia, nisi quatenus motus illi per aeris resistentiam aliquantulum retardantur."

In these days of the Fletcher trolley and Atwood's machine it would be interesting to know what were the experiments Newton had in mind as confirming dynamical principles. Mach has pointed out the great achievement of Galileo in arriving at the First Law of Motion, but he does not assign him credit for a knowledge of the Second Law. It is quite apparent from the above quotation that in the time of Newton there existed a tradition that Galileo's teaching of dynamics embodied the Second Law as enunciated in the "Principia." This is borne out by Lagrange in his introduction to the second part of his "Mécanique Analytique," in which he states that the Second Law is contained in the note added by Viviani at the suggestion of Galileo to the "Dialogues of Two New Sciences" (Eng. Trans. Crew and De Salvio, p. 184), deducing that the speeds falling down planes of different inclinations but of the same height are equal. In this note it is assumed as self-evident that the accelerations of a given body are as the forces producing them. This result combined with the fact that all bodies have the same gravitational acceleration corresponds to the form ($F/w=a/g$) recommended for elementary teaching and favoured by Sir George Greenhill.

The acknowledgment which Newton makes to Wren, Wallis, and Huygens for the discovery of the laws of impact is generally known in connexion with his description of his own experiments on impact. His attitude towards these experiments is different from that of the critical exposition of dynamics of to-day, in which the Third Law is placed in the position of honour from which the Second Law is derived by observation or experiment. With Newton, however, the Third Law requires justification, as shown by the conclusion of his description of his experiments on impact, "atque ideo actionem et reactionem esse aequales."

One other extract is worthy of attention. Under Definition III. of *materiae vis insita* Newton remarks, "Per inertiam materiae fit ut corpus omne de statu suo vel quiescendi vel movendi difficulter deturbetur." This objective view of inertia is better adapted for the general qualitative introduction to inertial mass than the innate view consequent on an initial statement of the First Law. This objective view frequently finds expression in elementary text-books, but might receive greater emphasis in view of the electromagnetic theory of inertia, and the initial discrimination between inertial mass and gravitational mass forced on us by the modern theory of relativity. The quantitative definition of mass as a measure of inertia merely interprets "difficulter deturbetur" in terms of acceleration. We may say then, as a preliminary to a more exact definition, mass is a measure of the difficulty of accelerating a body.

F. E. HACKETT.

College of Science for Ireland,
Dublin.

The Resonance Theory of Hearing.

I HAVE been reading with great interest various accounts of ingenious models made to illustrate the resonance theory of hearing, but I have been unfortunate enough to miss any clear reference to any structure in the cochlea which could respond on a physical basis to all vibrations which are capable of being appreciated by the human ear, or rather nervous system.

I have before me a pianoforte with a register of seven octaves, containing wires which vary from about 150 cm. in length and more than 0·4 cm. in diameter to wires 10 cm. long and tightly stretched. If the range were continued to the eleven possible octaves the extreme dimensions would be proportionately modified, being lengthened in the one case and shortened in the other. This, I take it, is the best pianoforte manufacturers can do, and that if they could have used shorter or finer wires they would have done so.

Let us turn then to the human cochlea and form some idea of its dimensions relative to such an instrument. It consists of a tube coiled two-and-a-half times, about 35 mm. in length, and varying from 4 mm. to 1 mm. in diameter. The total cubic contents of the cochlea, according to Sir Arthur Keith, are 70 cubic mm. The third canal of the cochlea has a diameter varying from 0·5 mm. to 0·8 mm. The basilar membrane has, according to Keith, a diameter varying from 0·17 mm. to 0·4 mm., with an average area of 13·2 sq. mm.

If the cochlea as a whole be considered, it can be likened in size to a stout silk thread 35 mm. in length. If the third canal of the cochlea alone be considered it can be likened to a silk thread 35 mm. in length, with an average width of 0·5 mm.

How is it possible to imagine structures of this order of magnitude capable of differential resonance to the vibrations of sound? From the ability of the investigators who have been dealing with the problem, I am certain that such an elementary difficulty cannot have escaped them for a moment, but I shall be grateful to any physicist who will throw light on a problem which is as difficult as it is fascinating. If the presence of anatomical resonators capable of responding to vibrations of the varying length indicated can be demonstrated, the resonance theory can well be considered. Otherwise it must be abandoned.

JAMES W. BARRETT.

105 Collins Street, Melbourne,
January 5.

SIR JAMES BARRETT'S letter expresses a difficulty in the way of acceptance of the resonance theory which I believe to be more generally felt than perhaps any other, namely, the difficulty of conceiving that a structure so minute as the cochlea, which may be compared in size to a small split-pea, can contain a series of resonators capable of responding to some 4000 separate tones extending over about 11 octaves. When we compare the suite of strings of a piano, which will respond only to 85 separate tones in 7 octaves, although they occupy with their case a space of 10 to 15 cubic feet, and weigh several hundredweight, the whole conception seems indeed bizarre and absurd.

This difficulty may be considered under two headings:

(1) How to account for the minuteness of the scale.

(2) How it is possible to have such a wide range of tones within so small a cubic space.

(1) *Scale.*—If it be granted that we are to look for our resonating elements in the transverse fibres of the basilar membrane, the scale of the cochlea will be determined by the length of these fibres. This again will be determined by the formula

$$\text{Number of vibrations per sec.} = \frac{1}{2 \times \text{length of string}} \sqrt{\frac{\text{tension in dynes}}{\text{mass of unit length of string}}}$$

or

$$n = \frac{1}{2l}\sqrt{\frac{t}{m}}.$$

It is obvious that in this formula, for any particular value of n, l can be given any value we choose by assigning suitable values to t and m. Theoretically, there is no reason why the resonators should not be 10 or even 1000 times smaller than they are in the cochlea. Practically, the limits of what is possible are set by the strength, fineness, and flexibility of the materials available. The particular factor which renders this extraordinary reduction of scale possible is, that in the cochlea the factor m is large out of all proportions with what obtains in any of our stringed instruments. This result is attained by the beautiful mechanical device of loading the strings each with a definite mass of cochlear fluid.

(2) *Differentiation.*—The fibres of the basilar membrane are differentiated for length, tension, and mass just as are the piano strings. Accepting Keith's measurements, the differentiation for length is sufficient to account for 1½ octaves; that for mass (as determined by the "fluid load") for about 2½ octaves. The remaining six to seven octaves of the audible scale must be due to variations of tension, as applied by the spiral ligament. This means a proportion of something like 1 to 5000 or 10,000 between

the lowest and highest tension. In a good section of the cochlea the spiral ligament will be seen to exhibit a progressive differentiation in bulk and closeness of texture not inconsistent with such extremes of tension. Further, the upper and lower limit of tension can be roughly calculated, and the resulting values are possible ones. The highest is only about a quarter of the breaking strain of tendinous structures of the same fineness.

Helmholtz recognised quite clearly the bearing of the "load" on the basilar fibres in rendering possible the small scale of the cochlea, though he failed to realise the *progressive differentiation* of the fibres for mass thereby effected. He says, "That such short strings should be capable of corresponding with such deep tones must be explained by their being loaded in the basilar membrane with all kind of solid formations; the fluid of both galleries in the cochlea must also be considered as weighting the membrane, because it cannot move without a kind of wave motion in that fluid" (second English edition translated by A. J. Ellis, p. 146).

No doubt if Helmholtz had known the anatomical structure of the spiral ligament, which was described by Albert Gray in 1900, the whole mechanism of the cochlea would have been clear to him.

George Wilkinson.

387 Glossop Road, Sheffield.

Stirling's Theorem.

In starting from $dn=1$ and then making dn infinitesimal, Dr. Satterly's demonstration in Nature of February 17, p. 220, is scarcely convincing, and the error introduced by this step is represented in his answer by the absence of the factor $1/\sqrt{n}$ or the term $\frac{1}{2}\log n$, neither of which is entirely negligible when n is large. I suggest the following adaptation of his proof, which avoids, I think, the inconsistency referred to above.

$$\operatorname{Log} \overline{n+1} - \log n = \log (n+1).$$

$\therefore$ by Taylor's theorem

$$(D + D^2/\underline{2} + \ldots)\log n = \log n + 1/n + \ldots$$

all terms on the right being negligible after the first when n is large.

$$\therefore \log n = \frac{1}{D + D^2/\underline{2} + \ldots}\log n$$

$$= \frac{1}{D}(1 - D/2 + kD^2 +)\log n$$

$$= \int \log n\, dn - \tfrac{1}{2}\log n + k/n + \ldots$$

$$= n\log n - n - \tfrac{1}{2}\log n + C.$$

The constant can readily be evaluated by the use of Wallis's expression for π.

James Strachan.

20 Woodside Terrace, Darlington,
February 23.

Echinoderm Larvæ and their Bearing on Classification.

Though loth to prolong this discussion, I wish, in fairness to Dr. Mortensen and myself, to say that I did not accuse Dr. Mortensen of regarding the echinoderm metamorphosis as a case of metagenesis. What I did write in Nature for December 8, 1921, seems to agree entirely with Dr. Mortensen's statement on March 10, 1923—a statement accepted by Prof. MacBride.

Against Dr. Mortensen's view, that the sucking disc of Brachiolaria is a relatively recent acquisition, Prof. MacBride would cite me as in substantial agreement with himself (Nature, January 13). That agreement extends to our common belief that all groups of echinoderms have passed through a fixed stage at some time in their ancestral history. On the precise relation of that fixed stage to the adult structure in the case of the starfish, we do not agree. Dr. Mortensen, it appears, is one of those who support my particular view. The sucking disc of the Brachiolaria has certainly been regarded by me, as by Prof. MacBride, as confirmatory evidence of the general theory. But if, as Dr. Mortensen now suggests, it be a secondary development, the theory does not necessarily fall, and Dr. Mortensen distinctly says that it does not. On the other hand, assuming Dr. Mortensen to be correct in his assertion that the forms with such a larva are only the more specialised, the sucker may none the less perpetuate an ancestral structure.

Until the geological history of the starfishes has been more fully worked out along the lines followed by Dr. W. K. Spencer, it is safer to express no opinion on the classification of the forms now living.

F. A. Bather.

March 11.

Constitution of Black Maketu Sand.

We have made a careful chemical and X-ray analysis of the black sand from Maketu, N.Z., from which Dr. Alexander Scott believed he had isolated the oxide of a new element. We are able to confirm Prof. Bohr's conclusion that no new element is present.

Starting with 1000 grams of the sand we obtained 1·7 grams of material free from silica, and insoluble in sulphuric acid. Fusion with sodium bisulphate did not bring this into solution, thus confirming Dr. Scott's experience, but it is interesting to note that on fusion with *potassium* bisulphate the residue went into solution completely, and was found by both chemical and X-ray analysis to consist of about equal parts of iron and aluminium. Prof. Bohr found an appreciable quantity of titanium in the residue, while we found no more than a trace; but as our residue was only 0·2 per cent of the ore our extraction was probably more complete.

C. J. Smithells.
F. S. Goucher.

Research Laboratories,
General Electric Co., Ltd.,
Wembley, March 8.

Scientific Periodicals for Czech Students.

I have recently received a most earnest and pathetic request from a group of Czech students at the University of Prague asking me whether this Society could send them an English scientific periodical. Unfortunately we have no funds for this, but it has struck me that it might be possible for some of your subscribers, who perhaps do not have their copies of Nature bound, to let me have them to send to these students. It would be a really kind and charitable act, and would be helpful in promoting the good feeling between ourselves and the Czecho-Slovaks, which is so useful at the present time.

If the papers were to be sent from London, I could arrange to call for them at stated times, so that no trouble of packing or postage would be involved.

B. O. Tufnell.

The Czech Society of Great Britain,
Kensington Palace Mansions, W.8, March 2.

The Egyptian World in the Time of Tutankhamen.

By Dr. H. R. HALL.

THE name of Tutankhamen, king of Egypt, whose reign may with comparative certainty be placed in the decade 1360–1350 B.C., is now a household word, and is probably known to many who have never heard of Thothmes or Rameses. The discovery of his tomb at Thebes by Lord Carnarvon and Mr. Howard Carter, with its wealth of funerary furniture and the magnificent state which probably enshrines the actual body of the king, has made Tutankhamen familiar to all; so that, at any rate for the time, we regard him as the typical Egyptian pharaoh of his age. But, as a matter of fact, he was an ephemeral and undistinguished monarch personally, and his short reign is only remarkable for one fact, the return of Egypt to the polytheistic faith of her forefathers after the short episode of the Disk-worshipping heresy of his father-in-law, Akhenaten, the artist, poet, and pacificist, one of the most extraordinary figures of the ancient world.

Akhenaten is the outstanding figure of his century, but he, again, is not the typical great king of his time: it is his father, Amanhatpe or Amenhotep III., the Memnon of the Greeks, who can rightly claim that position. Akhenaten was too strange and unconventional a figure. Tutankhamen began by following the heresy of his father-in-law, but in his day the reaction came, and the great god Amen of Thebes, king of the gods and head of the imperial pantheon, returned to his own. It is probably on this account that Tutankhamen was buried in the magnificent splendour that we see: Amen-Ra and his triumphant priests saw to it that the returned prodigal received fitting burial, with all the provision that the old religion could give him to ensure his dignity and well-being in the next world.

It is at the moment of his return to the national religion's fold that we survey the state of the world as known to the Egyptians, for to go further afield would bear us into endless paths of speculation. Egypt and Mesopotamia give us the only known chronological bases for real history at this time; to go outside their world, into the Bronze Age of Western Europe, for example, would be to cast loose from the control of known dates and events and to speculate merely as to the probable growth of civilisation, not to write history.

What was the world like outside Egypt, as known to the Egyptians, in Tutankhamen's day?

About 1580 B.C. the Syrian and Canaanite invaders who had dominated Egypt for at least two centuries, the Hyksos or Shepherd-Kings, had been expelled by force, and the Egyptians, filled with the spirit of *revanche*, had in their turn imposed their rule on the lands of their oppressors. The raids of the earlier kings of the XVIIIth Dynasty, which now occupied the throne of Thebes, had crystallised under Thutmases, or Thothmes, III. into a settled policy of conquest and empire, and Amenhotep III. was the undisputed ruler of Syria, Palestine, and Phœnicia.

These countries were regarded by the kings of Babylon and Assyria as the rightful domains of the king of Egypt, their peoples as his subjects. He was their lord in peace and war. Egyptian residents and generals controlled the native princes. The Egyptian frontier ran from the Amanus and north of the Aleppan district to the Euphrates near Carchemish, and thence down the river for some distance, till it turned off and ceased in the undefined wastes of the desert, reappearing at the head of the gulf of Akabah, in the land of Edom. The great historical cities of Syria, Aleppo, Carchemish, Damascus, and Jerusalem; the Phœnician cities of the coast from Arvad in the north, past Byblos, of old an Egyptian centre, Tyre, and Sidon to Akko in the south; the towns of the Philistine coast, from Dor to Gaza; had already existed for centuries. But though the Phœnicians were there, the Philistines were not yet in the land which afterwards bore their name, Palestine. They did not arrive in Canaan till nearly two centuries later.

Outside the Egyptian border to the west, in the days of Amenhotep III., the ancient kingdom of Babylonia existed in august but somewhat faded and inert majesty, as old as Egypt and as proud, but weak and querulous, trusting to the power of old renown as her protection against attack rather than to warlike prowess. Officially she now bore the name of Karduniyash, an appellation given her by the kings of her foreign Kassite dynasty, a race of conquerors, probably of Indo-European origin, who had come from beyond the Zagros some four centuries before.

North of her, on the Tigris, was Assyria, also an ancient power, but younger; Babylonian in culture, but more purely Semitic in race; and rejecting the claim to suzerainty which Babylon sought to impose on her. To the west of Assyria was the ill-defined kingdom of Mitanni, the land of Northern Mesopotamia between the Khabūr, the Euphrates, and the mountains of Diarbekir, inhabited by an intrusive race of uncertain origin ruled by kings probably, like the Kassites, of Aryan origin.

Farther west, beyond Taurus, was the confederation of tribes of the Anatolian Hittites, who owed allegiance to an overlord, the "Sun" of Khatti, reigning in central Anatolia, at a city represented by the modern Boghàz Köi, east of the Halys. The ancient Semitic population of Cappodocia no longer existed, having been destroyed or expelled by the Hittites.

Hittite tribes had already crossed the Taurus, inhabited the districts of Aleppo and Carchemish, and had even pushed outposts down as far south as Palestine, where they lived under Egyptian rule, side by side with the Canaanites and with Aryans from Mitanni.

South of the Anatolian Hittites was Cilicia, inhabited by a kindred race, of whose culture we know little, but that it owed much, probably, both to the Hittite and to the Syrian.

The island of Cyprus, the people of which also were racially related to the Anatolians, probably, had recently been conquered by Ægean tribes from Rhodes and Greece itself, who brought with them the Mycenæan culture, now beginning in Greece to take the place of the Minoan civilisation of Crete from which it was derived. The Minoan civilisation was now eclipsed on account of the collapse of the dominion of Knossos, which had sent ambassadors to Egypt in the days of Thothmes III.

This was, leaving out of account the Sudan in the south and the wild Libyan tribes to the west, the world as known to the Egyptians. Of Italy, they probably had as yet no knowledge.

Towards the end of the reign of Amenhotep III. a revolution broke out in Syria and Palestine. Shubbiluliuma or Suppilulius, king of the Hittites, a monarch full of guile, aspired to oust Egypt from the control of Syria and to destroy Mitanni. He found tools ready to his hand in certain discontented and rebellious Amorite princes of the Lebanon and in the Phœnicians of Arvad, and stirred up strife. Amenhotep quelled the revolt for a time, but it broke out again, and when his extraordinary son, Akhenaten, ascended the throne, the whole country seethed with turmoil.

The new king was interested only in his project of reforming the Egyptian religion; he was a man of art and of peace, and for the first time in history, perhaps, a great king refused to go forth to war, and allowed his dominions to fall away from him.

Palestine and Syria were in chaos. Wandering tribes, among them those Khabiri who have been credibly identified with the Hebrews, overran the land, the Hittite princes of the south revolted, and with them certain chiefs of Aryan (? Mitannian) origin who also had settled there under the Egyptian dominion. The Canaanite chiefs and Phœnician princes who remained faithful were gradually borne down in the absence of help from Egypt, and at the end of Akhenaten's reign the whole country had fallen away from the king.

In Tutankhamen's day the great prince Huy may represent himself on the walls of his tomb, as he does, bringing Semitic chiefs to offer tribute to his majesty, but we see that this can have been but a farce: the king's writ ran no farther than the coast of the Shephelah, probably. In the north the Amorites had but exchanged one master for another, for they now became the vassals of the Hittites, albeit under a looser control than that of Egypt. The Hittite control of Syria continued unchallenged till the days of Seti I. and Rameses II., fifty years later, when Egypt essayed to reimpose her yoke on the Semites. Long wars ensued, waged directly by Egypt against the Hittites, until about 1279 B.C. a peace of exhaustion was concluded between the protagonists, a peace of which we have the full protocol, signed and sealed by the Great King of Egypt and the Great King of Khatti, couched in diplomatic and legal phraseology that might have issued from a modern chancellery. It was a compromise: of her old Asiatic dominion Egypt retained only Palestine; Syria fell to the Hittites and remained theirs till, eighty years later, the invasion of the Philistines and their seafaring allies from the North overthrew the Hittite kingdom and tore Palestine itself from Egypt.

Tutankhamen, then, was confronted across his attenuated frontier by a far more formidable foe than the Babylonian could ever be. Mitanni was gone—destroyed by Shubbiluliuma after all help from Egypt had proved vain. Assyria, trusting in the prowess of her soldiers, kept her independence of both Babylon and Khatti; Shubbiluliuma seems prudently to have let her be. Her king, Ashur-uballit, was a long-lived and probably a politic as well as a doughty ruler. Somewhat later, in the time of Rameses II., Shalmaneser, king of Assyria, was a much more powerful monarch than the Babylonian Kadashman-turgu, and it was partly in apprehension of his power, probably, that Rameses and Khattusilis, the Hittite ruler, finally compromised their differences.

The collision of different national civilisations at this time produced none of the mutual approximations that might have been expected. Only Egypt began to show signs, more accentuated later, of Semitic influence in her culture. Babylon, however, shows no signs of Egyptian influence, the Hittites perhaps a little, the Mycenæans more. But there is no landslide in any direction anywhere. Each people remained faithful to its traditions. There were colonies of Mycenæan artists, as of Semitic and even Hittite craftsmen in Egypt. But though the Egyptians prized and used Greek products, we find no direct imitation of Minoan art even in the free and untrammelled Egyptian art of Akhenaten's time, though the works of the Minoan artists must have appealed to the realistic and truth-loving king. There is no trace of Minoan or of Mesopotamian influence yet in any of the objects of Egyptian art discovered in Tutankhamen's tomb of which photographs have been published: the weird heads, for example, of one of the gilded couches that have been thought to be Mesopotamian in aspect are merely heads of the Egyptian goddess Thoueris in her fierce and typhonic character. We should, in fact, expect Mesopotamian influence less than Minoan or even Hittite. The Thoueris-head was adapted by the Minoans for the heads of their water-demons.

Such, in brief survey, are the main characteristics of the outer world known to Tutankhamen and his people, and of Egypt's relations with it.

Recent Advances in Photographic Theory.[1]

By Dr. C. E. K. Mees.

The study of the physico-chemical relations on which depend the form in which a precipitate is produced has been developed by a number of workers in recent years, and its application to the precipitation of silver halide has been studied by Sheppard and Trivelli. In his earlier work Trivelli made a large number of photomicrographs of emulsions taken from standard photographic plates and films, one of which is reproduced in Fig. 1. It will be seen that the silver bromide grains, of which the emulsion is composed, are of very varied sizes, there being present a large number of small grains, down to the limit of those visible with a microscope, and a smaller number of large grains, including some of very much greater area than the smallest grains present. The largest grains are all polygons, with angles of 60° and 120°. There is a tendency to round off the corners and edges of the small grains, so that the smallest grains appear to be more or less spherical.

[1] Communication No. 165 from the Research Laboratory of the Eastman Kodak Company. From a lecture delivered before the Franklin Institute of Philadelphia on December 7, 1922.

A study of these small spherical grains by R. B. Wilsey, however, using the methods of X-ray crystal analysis, shows that even the smallest grains are still definitely crystalline and have the same structure as the large grains, the crystalline form being a cubic lattice.

So long ago as 1915 it was realised that the distribution of the different sizes of grains in an emulsion might play a very important part in determining the characteristics of that emulsion. The problem was to measure the distribution of the grains; that is, the number of grains of a given size which occurred in an emulsion and the variation of the number with the size of the grain. This problem has often arisen in scientific work. It has been studied in connexion with suspensions of all kinds. Various indirect methods of attacking the problem have been suggested. It is possible to get determinations by settling the emulsion, taking advantage of the fact that the larger particles will settle most rapidly according to Stokes's law, but the direct method is, clearly, to spread out

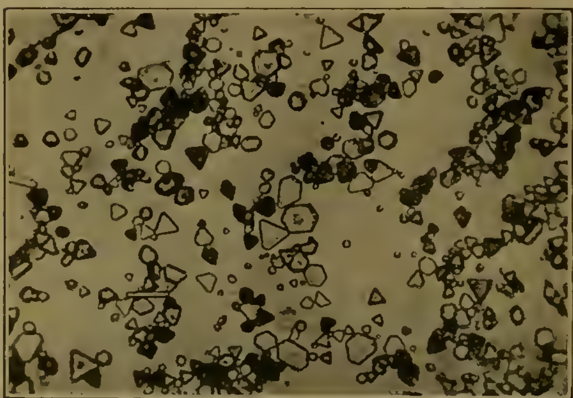

FIG. 1.

a thin layer of the emulsion and to count the different sizes of grains occurring in it. Trivelli photomicrographed a thinly coated emulsion at an enlargement of 2500 diameters, enlarged the negatives to 10,000 diameters, outlined all the grains of these enlargements, and then planimetered the grains and obtained tables showing the areas of the different grains present, at least a thousand grains being counted for each emulsion. Sheppard and Wightman obtained the same results by the use of the camera lucida instead of photomicrography. From these tables curves were obtained showing the relation between the size of grains and the number present for several standard emulsions. Fig. 2 shows the results for the portrait film and slow-lantern emulsions. It will be seen that the curve shows a distribution of sizes of grain which corresponds approximately to a probability curve, the maximum number of particles being of a diameter of approximately 0·5 μ, the particles both smaller and larger than this being fewer, until we have very few particles indeed of larger size than 2·7 μ and also few of smaller size than 0·2 μ. On this small side no particles can be measured less than 0·2 μ, because this is the limit of the resolving power of the microscope.

It is probable, however, that curves showing diameters will not be of real value, because the controlling factor will not be the diameter of the particles, but their projective area, as shown in Fig. 3.

Svedberg investigated systematically the relation between the size and sensitiveness of grains in photographic emulsions. He prepared emulsions so thinly

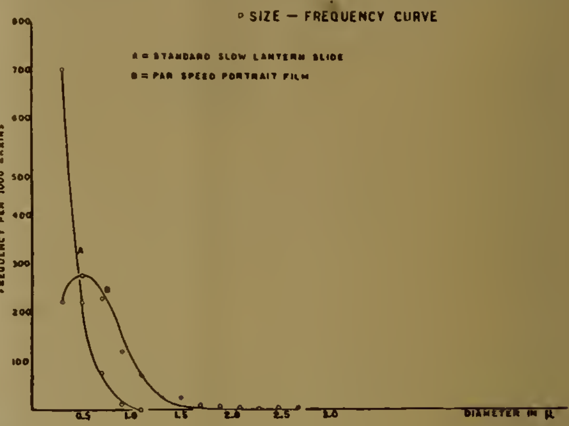

FIG. 2.

coated that the grains were all in single layers, and counted the grains of different sizes by classifying them into four classes. The emulsions were then exposed and developed, and the developed silver removed, the remaining grains, representing those which had not been made developable by the action of light, being counted. In this way curves could be obtained showing the sensitiveness of the grains of each class, and it was found, as might be expected, that the larger grains were much more sensitive than the smaller grains.

Svedberg next assumed that the product of the light action in the halide grain—that is, the substance of the latent image—consists of small centres distributed

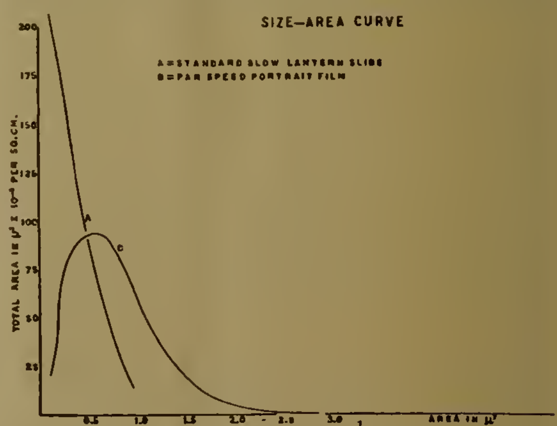

FIG. 3.

through the grain or through the light-affected part of the grain, and that these centres are distributed according to the laws of chance. If a plate be developed for a very short time the grains show these centres as small black spots upon them. This was shown by Hodgson as early as 1917 (Fig. 4).

Not only did Svedberg demonstrate the existence of these centres, but he also made plain their relation to the silver bromide grains by photographing the grains before development by deep red light, then developing for a short time and removing the undeveloped halide. On the plate there are then left small dots, and comparisons with the first plate showed these to correspond with the silver halide grains originally present.

Svedberg has shown that the number of centres produced in this way by initial development increases with the exposure in accordance with the usual photographic laws, and it might be assumed that the discovery of these centres produced during development is a proof of discreteness in the action of light upon the grain, and that they must result from a structure in the silver bromide grains existing either before exposure or produced during exposure, and corresponding, for example, to spots of sensitiveness. While the evidence for this seems very great, it must be remembered that we know nothing about these centres until development takes place, and that even if the whole grain were equally affected by the action of light and changed to the same extent, we should still expect development to take place first at some local spot corresponding to slight surface differences in the grain. A sheet of metal immersed in acid, for example, will not be attacked uniformly all over the surface. Because of the impurities, action will start at individual points.

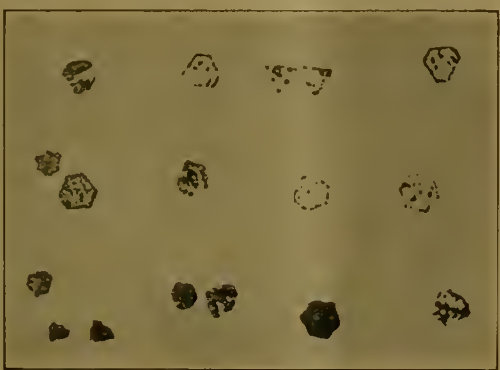

Fig. 4.

In a very important paper, Toy has given measurements showing that the number of nuclei produced on initial development are proportional to the number of grains which become developable on complete development, and that the larger grains not only have more nuclei on account of their size, but that these nuclei are also more sensitive to light than those in the smaller grains, the sensitivity of a grain being the sensitivity of its most sensitive nucleus. Svedberg considers that the number of developable centres per unit area of grain surface is a measure of the light sensitivity of the silver halide of the emulsion. From Toy's work it would seem to be doubtful whether we can speak of the light sensitivity of the halide itself in terms of the nucleus theory, since this will vary with the size of the grain.

Recently, a number of phenomena have been observed which are very difficult to explain by the use of the classical wave theory of light, and it seems not unlikely that it may be necessary to turn to a theory having some analogy to the corpuscular theory. As a first step towards this, Max Planck suggested his now well-known quantum hypothesis, according to which an atom radiating energy liberates it in discrete quanta, the amount of energy corresponding to each quantum being a constant multiplied by the frequency of the light. Bohr adopted Rutherford's theory of the structure of the atom, considering the atom to consist of a nucleus containing an electron carrying a positive charge of electricity, and to be surrounded by one or more electrons carrying a negative charge, the electrons revolving about the positive nucleus itself. He imagined that the electrons revolve without radiating, but that when an electron suffers some violent shock it gives up energy, and this energy is radiated and has the value of Planck's quantum. Thus, if an electron, by the sudden impact of another electron, for example, is thrown out of an atom and is attracted back to its place by the nucleus, then, as it falls back, it will send out a pulse of energy, and it will be seen at once that, if light is produced by such a behaviour of electrons, it is inherently probable that it will be radiated in pulses rather than continuously. Since, according to Bohr, the frequency of the vibration emitted is exactly proportional to the energy which the electron releases, Planck's quantum condition is fulfilled, and we have the famous equation,

$$Ve = h\nu,$$

where V is the voltage acting on the electron charge e, ν is the frequency, and h is Planck's constant.

In an X-ray tube the discharge of electricity is in the form of a stream of corpuscles travelling with a very high velocity, which depends upon the voltage of the electric current applied to the tube. When these corpuscles strike the target their energy is radiated in the form of X-rays, and we know that these X-rays partake very closely of the nature of light, except that the length of the waves is about one-thousandth of those of light, or, what is the same thing, their frequency is a thousand times as great. It is to this that they owe their great penetrating power.

On the classical wave theory of light, then, we should imagine that an X-ray tube having its target bombarded by the stream of corpuscles produced by the current would emit waves of X-rays spreading into space, just as waves of light are imagined to spread from a source; but now comes a great difficulty. When these X-ray waves travelling out pass through a gas and are absorbed, they cause the molecules of the gas to emit electrons, and these electrons are emitted with almost exactly the same velocity as the electrons in the tube which produced the X-rays themselves. The extraordinary nature of this phenomenon is well illustrated by Sir William Bragg in a recent article. He takes as an analogy the dropping of a log of wood into the sea from a height of one hundred feet. A wave radiates away from where it falls; the wave spreads; its energy is more and more widely distributed; the ripples die away; at a short distance, a few hundred yards, perhaps, the effect will apparently disappear. If the water were perfectly free from viscosity, and there were no other causes to fritter away the energy of the waves, they would travel indefinitely, always diminishing in their height. Now, at some point, say a thousand miles away, these now microscopic ripples encounter a wooden ship. We should expect that they would produce no effect, especially as they may have passed many other ships without having affected them, but, for some reason, as these tiny ripples reach the ship, a plank of the same weight as the log is hurled out of the ship to a height of exactly one hundred feet, and the whole energy which was originally supplied by the log falling into the water is concentrated upon the ejection of the plank. It will be seen at once how inadequate the wave theory is to account for this phenomenon. Similar difficulties occur in connexion with photo-electricity or the liberation of electrons under the influence of light.

The method by which a photographic emulsion adds up light during a long exposure has always been a great problem when it is considered from the point of view of the classical wave theory. If we accept the idea that the grains of silver halide in an emulsion are exposed to a continuous flood of light from a distant star, for example, then each grain must be imagined to be integrating light until it has received enough to make it developable. Since the exposure required in astronomical photography is frequently very long, we must consider that the grains continue to integrate the light for many hours, and it is difficult to imagine any mechanism which would enable them to do this. The difficulty is enhanced by the fact that even a very brief exposure continues to produce an effect after an interruption of a long period, so that if all the grains have been affected by the first exposure, they must be capable of storing energy quite insufficient to make them developable and to hold this energy for a long period, and then resume its accumulation at the level where the interruption occurs. In the same way, when we study the exposure of the individual grains, even if we could imagine some mechanism by which the grains could store up the energy falling upon them until they became developable, we should expect that all the grains of the same size would become developable at the same time, unless, indeed, we assume the process of exposure to be autocatalytic in nature. When grains are examined under the microscope, however, some of them are found to have been affected before others. If we imagine that they all have become exposed to a uniform flood of light, we must consider that these grains differ in sensitiveness among themselves, and that the possibility of change on exposure, so that they become developable, is due to the presence of a sensitiser. This may be either concentrated unequally in the different grains or may form centres of sensitiveness similar to those supposed to exist by Svedberg and other workers in the field, who think that the centres found at the beginning of development are the origin of sensitiveness, and are present from the time of making the emulsion.

If we had no prior knowledge of the wave theory of light, however, it is clear that the simplest explanation of the sensitiveness of different grains would be that, instead of a continuous flow of light in the form of waves on to sensitive films, the light was falling upon it as a rain of projectiles, and that these projectiles made developable any grains that they hit, the grains that were missed not being developable, but being hit later if they continued to be exposed to the radiation. Naturally, the bigger the grains the more likely are they to be hit, so that a calculation can be made of the relation between the size and the percentage number of grains which will become developable after a given exposure.

Silberstein suggests that the projectiles, rather than being called "corpuscles," which gives the idea that they are round, should be called "light darts," and should be imagined to consist of a long train of waves of very small diameter travelling with the velocity of light.

It is obvious that this theory of light darts would meet the difficulties which are offered by the phenomena of X-rays and photo-electricity to the idea of a continuous wave front, while not excluding the possibility of the formation of interference and diffraction effects. At first sight it would seem to offer a solution of the problem of the integration of exposure by the silver halide grains of the emulsion, since we might assume that, instead of a grain integrating energy falling upon it until it had received enough to make it developable, it was not affected at all until struck by a quantum of light, and then became developable completely. If this was so, however, we should expect that the amount of energy necessary to make a grain developable would be, on the average, one quantum, and at most a few quanta, more than one being necessary because of the chance that a fresh grain would not be struck by every "light dart" falling upon the emulsion, some falling between the grains and others striking grains which were already developable.

In some work which has just been started in our laboratory we are getting results from which I think we may conclude as a preliminary statement that, for high-speed emulsions, several hundred quanta of violet light are necessary per grain in order to make the grain developable. If this is confirmed, the light dart hypothesis would seem to be scarcely sufficient by itself to explain the integration of energy by the emulsion, and we are thrown back on to the idea of differential sensitiveness among the grains, or of spots of limited area on the grains, so that of the hundreds of quanta striking a grain only one may be considered to be operative, the rest falling upon the insensitive portions of the grain. Suppose that the fraction of a grain which is sensitive is ϵ, and this consists of an average of $\bar{K}$ spots of ω area, then

$$\bar{K}\omega = \epsilon a.$$

Now, if a grain has no spots, it will be quite insensitive and will not be developable, no matter how long it is exposed, so that the value of $\bar{K}$ and ω can be determined experimentally by counting the grains left over after a very prolonged exposure.

In any case, a question of great importance in connexion with the latent image is the amount of energy required to make the silver halide developable. If the new determinations show that several hundred quanta of violet light per grain are necessary, then a revision of ideas relating to the latent image itself will follow, as compared with those ideas derived from the belief that the energy available is only one quantum per grain, in which case it is clear that the latent image must depend upon a change occurring in a single atom of silver or halogen, since the only work we can imagine one quantum capable of doing is to release a single electron from an atom. If several hundred quanta per grain are available, then it is clear that not one atom of silver per grain may be affected, but that several hundred atoms may be changed, and that an appreciable, though very small, amount of chemical decomposition may be effected by the energy available.

More important still, quantitative differences in the amount of latent image present in a grain become possible. If only one quantum per grain is available, a grain is either exposed or not exposed, but if energy corresponding to an amount of several hundred quanta is used, we might imagine that a grain could become partly exposed, so that, for example, it might be developable by a developer of high reduction potential but not by one of lower potential. Moreover, grains might clearly be of different degrees of sensitiveness—that is, they might require different amounts of energy to make them developable—and the whole idea of quantitative differences in sensitiveness and exposure, which is so difficult if we imagine one quantum of energy per grain to be sufficient to produce a complete change in the grain which will make it developable, becomes perfectly intelligible. On the other hand, the division of the sensitive area into a number of small sensitive spots, which accords with the ideas both of Silberstein and those of other workers such as Svedberg who have located sensitiveness in "centres," would still enable us to retain the idea that a single quantum of energy is sufficient for exposure if it reaches one sensitive spot.

Obituary.

Dr. James Gow.

THE lamented death on February 16 of Dr. James Gow, formerly headmaster of Westminster School, and author of "A Short History of Greek Mathematics," calls for notice in NATURE. Educated at King's College School, Gow went to Trinity College, Cambridge, in 1871, and was 3rd Classic and Chancellor's classical medallist in 1875. He was elected fellow of Trinity in 1876, the year in which it was observed as a curiosity that the four fellows of Trinity then elected all had monosyllabic names and mustered no more than fifteen letters between them: Cox, Hicks, Lord, Gow. Three of them, including Gow, rowed for the historic Second Trinity Boat Club, now extinct.

Gow's mind was alert, quick, and versatile; he could have succeeded at almost anything he undertook. The son of an artist, he had himself decided talent in the same direction; he was, as an undergraduate, devoted to music. But his main work was in classics, and even there his interests were very varied. His fellowship dissertation was on the origin of grammatical gender; he edited the Odes and Epodes and the Satires of Horace; and he produced one of the most useful books ever written for schoolboys, a "Companion to School Classics"—a pioneer work which gave a lead to more ambitious and bulky handbooks since issued from the University Presses and elsewhere.

The "Short History of Greek Mathematics" is another proof of Gow's versatility. His original intention was to write a history of the city of Alexandria. He contemplated a chapter in that work which should deal with the mathematical school from Euclid to Diophantus. But this project led him insensibly to more general mathematical topics, such as the development of numeral systems, Egyptian arithmetic, Greek calculation and Greek theory of numbers, with the result that the material accumulated became too extensive for a chapter in a more general history, and he decided to make Greek mathematics the subject of a separate work. Such a book was very much wanted; here, too, he was breaking new ground. There were three recent and important German works by Bretschneider, Hankel, and Moritz Cantor, but no book in English at all comprehensive. The undertaking was the more arduous in that Gow had made no special study of mathematics since his schooldays, and it is no small proficiency in mathematics that is required for the compilation of such a history. The work proved a little uneven owing to the fact that the arithmetical portion was written on a scale too large to allow of the history of geometry being treated with equal fulness if the whole work was to be in a reasonable compass; and Gow realised that with "a history like this . . . the utility will no doubt vary as the brevity" (p. 145).

The best possible test of a book is, perhaps, the impression that it makes upon a reader who takes it up thirty or forty years after its publication. This book stands the test well. It is true that the mass of the material that must be included appeared to Gow at times to be overwhelming: for he speaks in his preface of the labour having often been dreary. But this certainly would not be gathered from the finished work, which is from first to last anything but dreary. Many things in it have necessarily been superseded as the result of subsequent researches, but the book can still be read with the same pleasure as it aroused on its first appearance.

T. L. H.

Rev. William Wilks.

HORTICULTURE is the poorer by the sudden death on March 2 of the Rev. William Wilks, vicar of Shirley, Croydon, 1879–1912. The son of Dr. G. F. Wilks, born at Ashford, Kent, on October 19, 1843, William Wilks was educated at Clapham and Pembroke College, Cambridge, where he took his degree in 1864. He was intended to follow his father's profession, but forsaking that course, after studying at Wells, he took orders, and was appointed curate of Croydon in 1866. The rest of his life, except for his annual holiday on the Continent, or latterly in Scotland, was spent in that neighbourhood, and when in 1912 he resigned his vicarage he went to live and garden next door at the "Wilderness" which he had built, and where he died.

There is no need to speak here of Mr. Wilks's parish work—the concourse of local people at his funeral at Shirley showed how it was appreciated—but rather of his work in and for horticulture. For nearly sixty years he was intimately connected with the Royal Horticultural Society. His grandfather and father had both taken a keen interest in gardening at Charing and Ashford, and the curate of Charing, the Rev. J. Dix, for some time chairman of the Royal Horticultural Society's Floral Committee, was an intimate friend of his youth. His love of Nature and gardening was still further fostered by his education under Prof. Pritchard, and by his vicar at Croydon, Canon Hodgson, so that when he went to Shirley he was well equipped to follow his bent in the large garden of the vicarage. He became a member of the Royal Horticultural Society's Floral Committee about 1880, and at the great reconstruction of the Society in 1888 he was appointed honorary secretary. He filled the post of secretary until 1920, when he retired and was elected to the council.

In 1888 the Society was in very low water; its liabilities were great, its finances low; it had less a horticultural than a social policy; it seemed doomed to early wreck, after weathering the storms of eighty-four years. With its new secretary, Sir Trevor Lawrence, Sir Daniel Morris, Sir William Thiselton-Dyer, Sir Harry Veitch, Mr. George Paul, Sir Michael Foster, Dr. Masters, and others, a determined return to a horticultural course was made, and in steering that course William Wilks took a leading part. He was a great secretary. A man of wide vision, a fine judge of men, courteous, tactful, able to bend men and things to the policy the new council had determined upon, cautious but ready to seize opportunity, loyal to his council and inspiring loyalty, ready with encouragement, kindly in restraining excess of zeal, an able organiser, under him the Society progressed from potential bankruptcy to financial prosperity, from a membership of about 1000 to more than 16,000, to the possession of its fine hall and offices, its Journal (which he edited from 1888 to 1906), its great garden at Wisley, with its school of horticulture and the development of research into gardening problems which all along he had seen to be essential to sound progress, and which, as soon as finance permitted, he fostered with all his power. His aim all through was to further British horticulture in its widest sense, and for his work for the Society, until it had been placed upon a sound financial footing, he took not even the most modest remuneration. The Society to-day is a monument to his work.

The gardens of the world, large and small, even into the Arctic regions, are the richer for Mr. Wilks's own gardening efforts, for from an aberrant field-poppy he raised the wonderful strain of Shirley poppies, and freely distributed seed every year to all comers. As with his poppies and foxgloves, he deemed no pains too great to spend upon the selection and increase of beautiful hardy things, and no pleasure to exceed that derived from sharing his beautiful things with others. His writings in the Journal were of these things. In his quiet garden he grew the choicest of hardy fruits, for he was a pomologist of no mean order, and he cared for and studied there the plants and animals it contained and attracted, with all the love of a true naturalist.

Sir Ernest Clarke.

Sir Ernest Clarke, a man of singular ability, and gifted in many different directions, was perhaps best known as secretary of the Royal Agricultural Society of England from 1887 to 1905.

Himself a Suffolk man, born at Bury St. Edmunds in 1856, Clarke had a special interest in East Anglia, and contributed largely to the enrichment of its archæology, literature, and folklore. In especial he showed himself an adept in unearthing the truth and in demolishing many of the erroneous statements that had found their way into past records. This same power marked his treatment of agricultural history and literature when, as the first Gilbey lecturer, he gave, in 1896, his series of lectures at the University of Cambridge, from which, in 1894, he had received the degree of Hon. M.A. Indeed, one may say that he was the first serious student of this subject since Arthur Young.

After service in the Local Government Board, and then as assistant secretary in the Share and Loan Department of the Stock Exchange, Clarke was selected in 1887, out of 106 candidates, to be secretary of the Royal Agricultural Society of England in succession to the late H. M. Jenkins. As secretary of the Society he distinguished himself by his great activity and powers of organisation. He had great ideals as to the position which such a Society as his should occupy as the leading authority both at home and abroad, and such he worked constantly to make it. For more than eighteen years he acted in this capacity, receiving the honour of knighthood in 1898. Later, however, came the disastrous days (1903–6) arising from the decision of the Council to abandon the peripatetic Shows and to have a permanent Showground at Park Royal, and this resulted in Clarke's resignation in 1905. He then returned to the City, and was associated, to the close of his active career, with various commercial enterprises.

Following on the death of his wife in 1918, Clarke was struck down with a paralytic seizure, and for the last four years of his life was unable to leave his room. But he retained to the end the clearness of intellect, and the interest in all around him, that had marked his active days.

Though he could never be called an "agriculturist," Clarke contributed largely to its history and literature, and the Journal of the R.A.S.E. contains many admirable reports of his, chiefly memoirs of noted agriculturists, such as Philip Pusey, Sir James Caird, the Duke of Richmond, etc., besides the "History of the Board of Agriculture," "Agriculture and the House of Russell," etc. To the series of King's Classics he contributed, in 1903, a new edition of "The Chronicles of Jocelin of Brakelond," an account of monastic life in the days of Abbot Samson, and he made many other contributions to archæological, historical, and folklore societies. He was an original member of the "Confrères"; and one of the "Sette of Odd Volumes"—being the "yeoman" in that body, and president in 1898. He was also a past-president of the Chartered Institute of Secretaries. Clarke was, in addition, a gifted musician, a brilliant conversationalist, and a man of much reading and wide general knowledge.

J. A. Voelcker.

Current Topics and Events.

By Clause 9 of the "Fees (Increase) Bill," the Government proposes to confer upon the Trustees of the British Museum a power which they have never sought and which, we are certain, they do not desire—a power to charge fees for admission to the Exhibition Galleries both at Bloomsbury and South Kensington. Of course, if the power is granted by Parliament, the Treasury will take good care that the Trustees exercise it. The precise proposal is to charge a fee of 6*d*. on Monday, Tuesday, Thursday, and Friday. How much better will anyone be for this? The probable receipts seem to us to be ridiculously overestimated by the Geddes Committee, since they only allow for a reduction in the number of visitors of less than one-half. Speculation on such a matter is rather idle. We know only that a charge of 6*d*. on three week-days at the Victoria and Albert Museum brought an average yearly return of 1000*l*. Against a possible income of, say, 1200*l*., have to be set expenditure on the installation of turnstiles and a considerable diminution in the receipts from the sale of publications, which has been greatly extended of late in both sections of the Museum. But this sort of haggling is beside the mark. The condemnation of this retrograde proposal depends on no nicely calculated less and more, but on the disservice that will thereby be done to popular education in its widest and highest sense. The nation will lose and the Museum will lose, for we may be sure that gifts in money and in kind will not flow so readily to a half-closed establishment. It seems, too, as though the Government would lose whatever popular support it now possesses. The British Museum has become in a very real and living sense a national possession, and the nation will refuse to be robbed of its free enjoyment.

The reluctance to discuss the monetary value of their services is a tradition which dies hard among the brain-workers in this country and abroad, and is in large measure responsible for the unenviable position of many salaried workers during and since the War. In the legal and medical professions, which occupy a legalised privileged position and are further safeguarded by the needs and the attitude of the community, professional unity is possible and demands for improved conditions of service and better remuneration for these classes are generally successful. The success of medical men in this country in particular has given an impetus to other professional workers towards combination, and various organisations now exist having for their avowed object the improvement of the economic position of the professional classes. In France, after approaching first the Confédération Générale du Travail, and later the General Association of Employees—both organisations of manual workers—the brain-workers have decided to form their own independent Confédération des Travailleurs Intellectuels. It is already in a position to exert considerable influence in the Chamber of Deputies and the Senate, and its success has provoked the creation of similar bodies in several other European countries. In this country there is an organisation, the National Federation of Professional Technical, Administrative, and Supervisory Workers, founded in 1920, having similar aims. Hitherto it has not been able to obtain the support of the medical, legal, engineering, teaching, or scientific associations. These may join the federation later, but, in the first instance, they will probably find it better to form their own federation. The time is certainly opportune for a movement to be made in this direction.

The sum of 1,000,000*l*. provided for agricultural research and education under the Corn Production Acts (Repeal) Act, 1921, has now been provisionally allocated for the furtherance of various schemes, and the details are outlined in the current issue of the Journal of the Ministry of Agriculture. The suggested grants cover a wide field, and in several cases are intended to be supplemented by certain moneys raised by the institutions benefiting therefrom. Dairying, silver-leaf research, and fruit growing are to be aided in various centres by the provision of building and maintenance funds, and a scheme is under consideration for the establishment of an Animal Pathology Research Station at Cambridge University. Support is also being given to the National Poultry Institute scheme, with special provision for research in various directions, for commercial experiments and for higher instruction in poultry keeping. On the educational side additions are being made to the research scholarships and travelling fellowships, the advisory services are to be completed and strengthened, while a considerable sum has been provisionally allocated for grants in aid of capital expenditure at university departments of agricultural colleges. County agricultural education will benefit in a similar way. The approximate allocation under the above headings is as follows: Research and Advisory work, 465,000*l*.; Higher Agricultural Education, 84,000*l*.; County Agricultural Education, 170,000*l*.; Scholarships for the sons and daughters of Agricultural workers, 117,000*l*.; Miscellaneous Schemes, 74,000*l*. Some re-arrangement of the above sums may, however, prove to be necessary as the schemes are more fully investigated and begin to be worked out.

The Retail Pharmacists' Union, in a recent announcement with regard to the subject of the accurate dispensing of medicines, describes the training required for the profession of pharmacy. The announcement is, however, headed with the words "The Chemist," and this has led Mr. A. Chaston Chapman, president of the Institute of Chemistry, to suggest again that the time has come for the pharmacist to relinquish the use of the term "chemist" in favour of those who definitely practise chemistry. Mr. Chapman points out that "the Institute of Chemistry, as the representative chartered professional body of chemists, numbers upwards of 4000 fellows and associates, whose qualification demands a four years' university course, or the equivalent, and the majority of whom are engaged in the many branches of industry on which the science has a bearing. In other countries the strict equivalent of the word 'chemist' signifies, as it should, one who professes chemistry, and not in any case the pharmacist, druggist, or dispenser of medicines."

THE summer meeting of the Institution of Electrical Engineers will be held at Manchester and Liverpool on June 5-8. Visits have been arranged to important electrical works in the locality.

A CONFERENCE of the Women's Engineering Society will be held at the University of Birmingham on April 11-14. Particulars can be obtained from the general secretary, Miss C. Haslett, 26 George Street, Hanover Square, London, W.1.

IN the new edition of Zittel's "Grundzüge der Paläontologie," lately published, Profs. Broili and Schlosser refer to the tooth of the supposed ape-man, Hesperopithecus, from Nebraska, U.S.A., as being a problematical specimen. They state that it may perhaps be the first milk-molar of a primitive horse.

THE Geological Department of the British Museum (Natural History) has just acquired the palæobotanical collection of Dr. Dukinfield H. Scott. It comprises more than 3000 microscope slides, chiefly of British Carboniferous plants, on which most of Dr. Scott's own researches have been based. It is a direct continuation of the Williamson collection which was acquired by the Museum in 1896.

IT is stated in the *Chemical Age* of March 10, that at the annual meetings of the American Chemical Society to be held next month, Prof. F. G. Donnan and Principal J. C. Irvine will be among the British delegates. The subjects for discussion will include motor fuels, the history of coal tar dyes, insecticides and fungicides, and the chemistry of cellulose.

IT is stated in a Press dispatch from Oklahoma City appearing in *Science*, that an amendment prohibiting the purchase of books or copyrights teaching the theory of the evolution of the human race was inserted in the State Free Text Book Bill which passed the lower house of the legislature on February 21. Only one dissenting vote was cast against the anti-Darwinian section.

THE Mueller medal and fund have been awarded to Mr. J. H. Maiden, Government Botanist of New South Wales and director of the Botanic Gardens, Sydney, in recognition of his botanical work. The medal was founded in memory of the late Baron von Mueller, Government Botanist of Victoria, and is awarded at each meeting of the Australasian Association for the Advancement of Science, which, in 1923, sat at Wellington, New Zealand. It has been awarded previously for botany, zoology, geology, and ethnology.

PROF. HORACE LAMB, late professor of mathematics in the Owens College and University of Manchester; Lord Meston of Agra and Dunottar, formerly Lieut.-Governor of the United Provinces of Agra and Oudh; and Mr. G. Gilbert Scott, Royal Academician, have been elected members of the Athenæum Club under the provisions of Rule II. of the club, which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

A SYMPOSIUM and general discussion on alloy resistance to corrosion will be held at the Department of Applied Science of the University, Sheffield, on Friday, April 13. The meeting is being organised jointly by the Faraday Society, the Sheffield section of the Institute of Metals, and the Manchester Metallurgical Society, and the scope of the discussion will include the new non-corrodible, non-ferrous alloys, such as stainless nickel silver and the nickel chromium alloys, as well as stainless iron and steel. A general introduction to the discussion will be given by Prof. C. H. Desch. Further particulars may be obtained from Mr. G. R. Bolsover, Brown-Firth Research Laboratory, Princess Street, Sheffield, or from the secretary of the Faraday Society, 10 Essex Street, Strand, London, W.C.2.

FARMERS' Clubs, Chambers of Agriculture, and other bodies or individuals interested in agriculture are invited to visit the headquarters of the National Institute of Agricultural Botany, Huntingdon Road, Cambridge, during the coming summer. They will be able to see trials of new varieties of wheat and barley in progress on the trial ground, and a collection of different varieties of various farm crops growing in the field. The buildings of the Institute will also be open to inspection; these include the Official Seed Testing Station for England and Wales, where testing of seeds is always being carried out. The most interesting period for inspecting the Institute is from June to August, and all who wish to take advantage of the invitation should communicate with the director of the Institute, Mr. W. H. Parker.

MR. T. SHEPPARD, the energetic Curator of the Hull Municipal Museum, by the publication of a series of pamphlets describing the collections in his charge, has done much to popularise the study of science and archæology, and has given an example to those in charge of similar collections. A recent publication is a list of the specimens of natural history, antiquities, and applied art. The museum dates from 1823, and the specimens collected by the Literary and Philosophical Society finally passed to the Hull Municipal Museum in 1902. Since then the collections, particularly of local scientific objects and antiquities, have been largely extended, and the museum now holds a high place among similar institutions. Its value has been largely increased by Mr. Sheppard's continuous efforts to bring the collections to the notice not only of local visitors but of those from a distance.

THE British Non-Ferrous Metals Research Association has adopted a somewhat novel way of communicating the results of its recent investigations to its members. Lectures are arranged at one or more centres to which only the members of the Association itself are admitted. Two objects are served in this manner: first, early confidential communication of the results of the research is assured to those who have given it financial support; and secondly, the investigator gets into close and immediate contact with that section of the industry chiefly interested in his work. This private lecture system has so far been applied to two subjects. Dr. W. Rosenhain has reported on the investigation on copper, and the influence upon its properties of small quantities of impurities, which is being carried out for the Association by Dr. D. Hanson and others at the National Physical Laboratory; and Mr. E. A. Bolton has described work on the cause and prevention of red stains on brass, which he is carrying out at the University of Birmingham.

THE Staff Association of the British Museum (Natural History) held, on March 8 in the Museum Board Room, a scientific reunion which was attended by about seventy members and visitors. Round the room were arranged a large number of interesting objects. Among the geological exhibits may be specially mentioned the portions of the fossilised skeleton of Baluchitherium, a gigantic perissodactyl ungulate from Baluchistan, recently described by Mr. Foster-Cooper. This species is closely related to the rhinoceros, and is the largest land mammal at present known. An exhibit of the fauna of submarine cables attracted much attention, particularly the portion of a cable, brought up from a depth of 750 fathoms, showing a shark's tooth broken off in the wire sheath. A series of mounted specimens of animals acquired by the aid of the Rowland Ward bequest were shown. The flattened crystal of diamond and the well-formed ruby crystal, both formerly in the John Ruskin collection, were on view. It being the intention of the Trustees to adapt a bay in the Central Hall for the purpose of displaying the South African elephant in its natural surroundings, Capt. Guy Dollman had prepared a model on a one-eighth scale to demonstrate the effect; artistically designed and executed and efficiently lighted, this model was exhibited, and proved very popular. Messrs. C. Baker demonstrated their most recent microscopes and accessories.

AN International Air Congress will be held in London on June 25-30 this year under the presidency of the Duke of York, when opportunities will be provided for the reading and discussion of papers on every aspect of air matters. The Congress will be divided into four groups (each again divided into sub-groups) which will meet simultaneously. Group A will deal with methods of research, aerodynamics, controllability, structural methods, materials, and alighting gear. Group B is subdivided into sections on fuels and lubricants, motive-power plant, air-screws. Group C will discuss air transport and navigation problems, and in Group D airship design and construction will be discussed. Further particulars can be obtained from Lt.-Col. W. Lockwood Marsh, General Secretary, International Air Congress, London, 1923, c/o The Royal Aeronautical Society, 7 Albemarle Street, London, W.1, England.

UNDER the title of "The Claim of Antiquity," the Councils of the Societies for the Promotion of Hellenic and Roman Studies and of the Classical Association have issued an interesting bibliography of books for those who know neither Latin nor Greek. It provides a list of the best books, originals or translations, dealing with the general subject of classical literature; the most important authors; philosophy and religion; history; geography; science; art and archæology; and social life, giving the prices of each publication. The volumes published in the excellent Loeb Library have done much to spread the knowledge of classical literature among those who are ignorant of or have forgotten their classical learning, and the present publication, compiled by experts, will do much to advance the objects which these classical societies have in view. It will furnish an acceptable addition to all school libraries.

THE Secretary for Mines invites applications for a research post under the Safety in Mines Research Board. Candidates must possess high general scientific qualifications and experience in engineering, with, if possible, a knowledge of coal mining. The person appointed will be required to advise on questions of research on the safety problems of coal mining, to prepare programmes of research, and to organise and superintend research work. Applications for the position must reach the Under-Secretary for Mines, Mines Department, Dean Stanley Street, S.W.1, by, at latest, April 30.

THE tricentenary of the birth of Blaise Pascal occurs on June 19, and preparations have been made for celebrations in France on July 8-9. The President of the French Republic will attend the meetings, the chief of which will be a commemoration gathering, to be addressed by the Minister for Public Instruction and other members of the French Academy. There will also be a meeting at the summit of the Puy de Dôme, when a member of the Academy of Sciences will speak on the famous experiment carried out there, at Pascal's suggestion, of observing the barometric height at the summit and comparing it with that at the base of the mountain. A difference of three inches in the height of the mercury column was observed, giving Pascal justification for his conclusion that the column of mercury in the barometer is supported by the pressure of the atmosphere.

AT the annual general meeting of the Geological Society held on February 16, the following officers and members of council were elected:—*President*: Prof. A. C. Seward. *Vice-Presidents*: Dr. J. W. Evans, Mr. R. D. Oldham, Dr. H. H. Thomas, and Prof. W. W. Watts. *Secretaries*: Mr. W. C. Smith and Mr. J. A. Douglas. *Foreign Secretary*: Sir Archibald Geikie. *Treasurer*: Mr. R. S. Herries. *Other members of council*: Dr. C. W. Andrews, Mr. F. N. Ashcroft, Prof. P. G. H. Boswell, Prof. W. S. Boulton, Dr. Gertrude L. Elles, Dr. J. S. Flett, Dr. F. H. Hatch, Prof. O. T. Jones, Mr. W. B. R. King, Dr. W. D. Lang, Prof. S. H. Reynolds, Sir Aubrey Strahan, Sir Jethro Teall, and Mr. H. Woods.

At the general meeting of the Asiatic Society of Bengal on February 7, the following officers and members of council were elected :—*President* : Dr. N. Annandale. *Vice-Presidents* : Sir Asutosh Mukhopadhyaya, Mr. Mahamahopadhyaya Haraprasad Shastri, Dr. J. Coggin Brown, and Lieut.-Col. J. D. W. Megaw. *General Secretary* : Mr. Johan van Manen. *Treasurer* : Prof. C. V. Raman. *Philological Secretary* : Dr. D. R. Bhandarkar. *Joint Philological Secretary* : Mr. S. Khuda Bukhsh. *Natural History Secretaries* : (*Biology*) Dr. P. J. Bruhl and (*Physical Science*) Mr. P. C. Mahalanobis. *Anthropological Secretary* : Ramaprasad Chanda. *Medical Secretary* : Major R. Knowles. *Honorary Librarian* : Dr. T. O. D. Dunn. *Honorary Numismatist* : Mr. C. J. Brown. *Other Members of the Council* : Dr. Upendra Nath Brahmachari, Mr. Kumar Sarat Kumar Roy, Sir R. N. Mookerjee, Mr. Pramatha Nath Banerjee, and Dr. W. A. K. Christie.

The Australian National Research Council is making preparations for holding an important Pan-Pacific Science Congress in Australia in August next. The sympathy and support of the Commonwealth Government has been secured, and it is expected and sincerely hoped that scientific workers representing all the countries bordering, or having interests in, the Pacific will send representatives to this congress. Already the Commonwealth Government has issued cordial invitations to the countries concerned, inviting them to join in making this congress a success. It is well known that in international matters the Pacific must play an important part in the near future, and a fuller knowledge of its peoples, its products, and its natural phenomena, from a scientific point of view, is urgently desirable. The first Pan-Pacific Science Congress was held at Honolulu in August 1920, and it is proposed that the Australian meeting should be opened at Melbourne on August 13, 1923, and on August 23 be transferred to Sydney, and terminate there on September 3. Arrangements are being made to deal with the following subjects : (*a*) agriculture and veterinary science ; (*b*) anthropology and ethnology ; (*c*) biology, including botany, entomology, zoology ; (*d*) geography and oceanography ; (*e*) geology ; (*f*) hygiene and climatology ; and (*g*) physics, including geodesy, geophysics, radiotelegraphy, and seismology. Among the office-bearers are the following : Australian National Research Council—Sir David Orme Masson, The University, Melbourne (*President*) ; R. H. Cambage, Royal Society, Sydney (*Hon. Secretary and Treasurer*) ; Prof. A. C. D. Rivett, The University, Melbourne (*Joint Hon. Secretary*). Pan-Pacific Committee — Sir Edgeworth David, The University, Sydney (*Chairman*) ; E. C. Andrews, Mines Department, Sydney (*Hon. Secretary*).

The projection of light in optical lanterns and kinema apparatus, discussed before the Illuminating Engineering Society on February 20, is a problem that evidently deserves more study. It appears from the results of recent tests that in most optical lanterns only about six per cent. of the light furnished by the source is usefully applied on the screen. In the kinema projector, with its small aperture and shutter, the percentage is even less. Moreover, even the light reaching the screen is not all profitably used, for much of it is reflected on to walls and ceilings and never reaches the eyes of the audience. Some attempts to utilise gas-filled incandescent lamps in place of arcs were also described, and the results of investigations seem fairly promising. Other items of interest in the discussion included a demonstration by Major Adrian Klein of his new colour-projector, and a three-phase alternating current arc shown by Mr. J. Eck. From a scientific point of view the Klein projector is particularly interesting, as the colours are not produced by means of filters, but by the aid of a train of prisms. When these spectrum colours are projected on painted scenery very vivid changes are produced.

The annual report of the Meteorological Committee to the Air Council for the year ended March 31, 1922, has recently been issued. It is the sixty-seventh year of the Meteorological Office and the second report submitted to the Air Council instead of to the Treasury as formerly. The meteorological service now comprises many meteorological organisations which in past years have been carried on separately and independently. In all, the total staff aimed at to complete the organisation is 375. Retrenchments undertaken, however, by all Government departments have led to some modified programmes for the meteorological service, and reductions in the staff have taken place instead of the wished-for augmentation. The total whole-time staff of the Meteorological Office and its out-stations has changed during the year from 266 to 261. The year has seen a great increase in the interest of seamen in weather information, and the report mentions that it is greatly to be regretted that this increased interest should coincide with conditions which have made it imperative to reduce rather than to extend the activities of the Marine Division. Data now being received are gradually getting back to pre-war conditions, when it was equally felt that excessive observations were costly. For forecasting work the report states that, although certain messages are still received by cable, almost all European countries have now adopted the use of wireless telegraphy, and it is growing evident that it will shortly be possible to dispense entirely with the exchange of messages by cable. Much information is given relative to aviation and the upper air, new developments entailing much organisation. The British Rainfall Organization is now controlled by the Meteorological Office, and among many other branches of work may be mentioned atmospheric pollution and the oversight of attached and subsidiary observatories.

The Journal of the British Science Guild for February contains a summary of the proceedings at the annual dinner in May last year. In proposing the toast of the British Science Guild, Sir Arthur

Mayo-Robson mentioned the interesting fact that Lord Curzon had distributed 500 prospectuses of the Guild's "Catalogue of British Scientific and Technical Books" to His Majesty's Consuls abroad. He also pointed out the thirst for scientific knowledge that was developing in various parts of the Empire he had recently visited, where fruitful opportunities for the work of the Guild appear to exist. Among others who spoke, Mr. H. G. Wells pleaded for a wide view of science, which should not be regarded as a monopoly for any nation, though they naturally hoped that the British Empire would make a worthy contribution to the general store of knowledge. The late Mr. F. W. Sanderson, whose genius as a schoolmaster is the subject of appreciatory editorial reference, emphasised the value of scientific methods in schools in developing a desire among boys to "get at the truth." He added that a catalogue of the British Scientific Products Exhibition had been of great interest to the boys. Other contributions to the journal cover wide ground. There are extracts from recent articles in the press on the Guild's national appeal. Prof. Flinders Petrie and Admiral Ballard have contributions on "The Science of Sailing." Dr. J. A. Harker deals with "The Fixation of Nitrogen," Mr. A. P. M. Fleming with "Radio-Telephony," and Mr. Leon Gaster with "Illuminating Engineering." Dr. R. S. Clay furnishes a note on "The British Pianoforte Industry." As usual the Journal also contains a series of readable notes illustrating the application of science in daily life.

Commander Hilton Young makes to us the suggestion that insects may be able to appreciate the proximity of a solid body by detecting the pressure differences which would be set up by air currents impinging on the latter. He asks whether this possibility has been examined, and a distinguished naturalist to whom we submitted the inquiry states that various entomologists have referred vaguely to insects being affected by changes of air pressure. Forel speaks of the sensitiveness of insects to slight movements in the air and to slight vibrations in his "Le Monde social des fourmis," vol. 2 (1922), and Folsom in his "Entomology" (1906) suggests that the sensillum placodeum may be affected by air pressure. Another work by Forel, "Sensations des insectes" (1886), and Berlese's "Gli Insetti," should also be consulted.

The firm of Mr. C. Baker, of 244 High Holborn, London, W.C.1, has issued the January number (No. 77) of its well-known classified list of second-hand instruments and scientific works. The catalogue is arranged in sections, each confined to a specific class of apparatus, and contains a number of useful items. Those in need of physical apparatus, microscopes, cameras, etc., would do well to consult this list.

Many students to whom Dr. A. Holmes's "Petrographic Methods and Calculations" is of interest and value will be glad to learn that the work, hitherto available only in one volume, will in future be obtainable in three separate parts dealing respectively with Specific Gravity, Separation and Determination of Minerals, and Detrital Sediments; Thin Sections; and Chemical Analyses and their Interpretation. The publishers are Messrs. Thomas Murby and Co., 1 Fleet Lane, E.C.4.

Messrs. H. K. Lewis and Co., Ltd., 28 Gower Place, London, W.C.1, are now issuing monthly lists of additions to their scientific and technical circulating library, instead of quarterly lists as previously. Every effort is made to meet the needs of workers in laboratories connected with the manufacturing industries, and the latest works on scientific research on all kinds of raw material and manufacturing processes are freely added to the library. These may also be seen in the technical books department, or a list will be sent to any inquirer.

With the assistance of prominent specialists in many parts of the world, Mr. Jerome Alexander, 50 East 41st Street, New York City, is preparing a comprehensive book on "Colloid Chemistry: Theoretical and Applied." British contributors include Dr. E. F. Armstrong, Prof. H. Bassett, Sir W. M. Bayliss, Dr. E. F. Burton, Mr. W. B. Hardy, Prof. F. G. Donnan, Mr. F. E. Lloyd, and Dr. A. E. Dunstan. Mr. Alexander invites any one who may have information of interest on experimental facts and practical applications of colloid chemical principles to send him a brief statement for inclusion in the book.

Messrs. Longmans and Co. have in the press "Friction," by Dr. T. E. Stanton, of the National Physical Laboratory, in which work the attempt is made to deal concisely with the whole subject of the mechanical friction which exists between bodies in contact, solid, liquid, or gaseous, under forces producing, or tending to produce, their relative motion. Attention is given to friction due to the flow of fluids over solid surfaces, with special reference to the dimensional theory; also to the lubrication theories of Osborne Reynolds, Michell, and Sommerfeld, and to the recent researches at the National Physical Laboratory on lubrication. The section on solid friction includes the theories of rolling friction and of the stability of structures on soft earth, together with the results of some modern experiments on materials used for brake blocks, and the final chapter is devoted to a discussion of Reynolds's theory of the relation between the heat transmitted to solid surfaces by fluids flowing over them and the frictional resistance of the surfaces due to the flow, and an examination of the experimental data bearing on this theory.

The spring announcement list of Messrs. Chapman and Hall, Ltd., contains many books of scientific interest, among which are: "Vital Factors of Foods: Vitamins and Nutrition," by C. Ellis and Dr. Annie Louise Macleod, aiming at furnishing all essential facts regarding vitamins, and at bringing together the literature on the subject; "Perfumes and Cosmetics: with Special Reference to Synthetics," by W. A. Poucher; and "Electric Lift Equipment for Modern Buildings," by R. Grierson, which deals with the selection, installation, operation, and maintenance of modern electric passenger, goods, and service lifts. The same publishers will also issue a new and completely revised edition of "Electrical Engineering Practice," by J. W. Meares and R. E. Neale, in two volumes, the first of which will be ready shortly.

Research Items.

THE PYRAMIDS OF MEROE AND THE CANDACES OF ETHIOPIA.—A new chapter in the history of Egypt has been disclosed by the work of the Harvard-Boston Expedition in the Sudan, of which a summary is given by Prof. G. A. Reisner in *Sudan Notes and Records*, vol. v. No. 4. About 900 B.C. a Libyan family occupied Napata and seized the roads from Egypt to the mines and the southern markets. Ethiopia was then a province of Egypt, and for the first time they made it an independent kingdom and Egypt one of its provinces. They were not negroes, but of a mixed brown race which had previously lived in Ethiopia. For about 80 years they ruled 3000 miles of the Nile valley, and they were finally driven back to Ethiopia, ruling at Napata and building their pyramids there. In the end the branch settled at Meroe became the more powerful, and this kingdom persisted uninterrupted for another 650 years. Thus it has fallen to the lot of the expedition to trace the history of this family through more than twelve centuries.

HEAD-HUNTING IN PAPUA.—In the March issue of *Man* Mr. E. B. Riley gives an account of the method of preparing the heads of enemies practised at the village of Dorro in Papua. After the flesh and brains are removed a piece of rattan cane is fixed to the bottom of the mummified skull to take the place of the lower jaw and to act as a support for the packing of the neck. It was difficult to ascertain why the lower jaw is not replaced. The explanation seems to be that they prefer to hang this up in the house, and keep it as a mark or token of the owner's prowess in war, when the mummified head is discarded on account of natural decay; but the lower jaw is sometimes replaced, being tied to the zygomas, as in the case of the rattan cane above described. Finally, the head is dried, being fixed on a wooden framework over a fire lighted for that purpose, and the hair is pulled out on the second day as decomposition of the skin advances. Following this paper is a description by Dr. A. C. Haddon of stuffed human skulls from the Fly River District, Papua, two of which are preserved in the Cambridge and Manchester Museums.

CRIMINAL TRIBES OF INDIA.—The problem of dealing with the nomadic, predatory tribes of India has been considered for many years by the Imperial Government. All sorts of repressive measures have been put in force; the tribes have been proclaimed and attempts have been made to segregate them in settlements under police control. This system has always broken down, and these people, including the Sansias of the Punjab, the Doms of the United Provinces and Bihar, the Yerukalas and Korachas of Madras, have continued to be a pest to the country, and much violent crime was committed by them. Some twenty years ago a proposal was made by the Salvation Army to take charge of these people, and the result of the experiment is described in a paper by Commissioner Booth Tucker, read before the Royal Society of Arts (vol. lxxi. No. 3661). The Salvation Army has collected some of these people in settlements, each in charge of a European, where the more respectable members act as police, industries are taught, and efforts made to raise their moral character. In the debate which followed the reading of this paper several experienced Indian administrators, including Sir E. A. Henry, Sir John Hewitt, and Lord Pentland, bore testimony to the success of the experiment, which may be said to have solved one of the most difficult problems of Indian administration.

FATIGUE IN LAUNDRY WORK.—Miss May Smith is to be congratulated upon her recent Report (No. 22) to the Industrial Fatigue Research Board (H.M. Stationery Office, price 2s. 6d.), embodying "Some Studies in the Laundry Trade." Owing to the great variety of articles dealt with in laundries, the measurement of output, so as to serve as an index of the relations between working conditions and the human factor, proved unusually difficult. Nevertheless, she has been able to show that there is a reduction in efficiency in laundries towards the end of the day, which tends to be greater during a ten-hour than during a nine-hour day. These conclusions are strikingly corroborated by the data afforded by the interposition of "dotting" tests, which, in addition, reflect passing variations in the health and mental state of the worker. Miss Smith finds clear evidence of the beneficial effects on efficiency which occur after a fifteen minutes' rest pause has been introduced into the morning spell, but the greatest influence on the laundresses' output appears to be due to the vast individual differences in the workers' efficiency. Apparently the atmospheric conditions of laundries compare very unfavourably with those in potters' shops, boot and shoe factories, and cotton-weaving sheds. But when conducted under good conditions, Miss Smith believes that laundry work is not detrimental to the health of the workers. The variations in health due to excessive standing, faulty movements, and improperly designed machinery receive attention, and recommendations are made in regard to supervisors, the provision of seating, unsuitable footwear, change of occupation, etc.

OUR OLDEST SETTLEMENT IN AFRICA.—Dr. Frank Dixey has followed up his physiographic description of the colony of Sierra Leone (see NATURE, vol. 105, p. 689, 1920) by a complete petrographic survey of the main promontory (Quart. Journ. Geol. Soc. London, vol. 78, p. 299, December 1922). The peninsula forming the colony proper has been carved out of a remarkably uniform and unusually large stock of norite, the fine-grained character of which indicates that the present surface follows that of a dome of intrusion. Veins of coarser norite, and some of aplite, cut this mass, which is regarded as post-Cambrian, but of ancient date. The only strata on its surface are post-Pliocene gravels. This extensive occurrence of basic igneous rock furnishes further evidence of the existence of a West African petrographic province of strongly magnesian character.

SURVEYS OF THE SAHARA.—A new map of the western Sahara, between the Atlas to the north, and the Senegal and Niger to the south, and the meridian of Paris on the east, is published in *La Geographie* for January. The map, which is on a scale of 1 : 2,000,000 is based on information collected by the French military posts in the Algerian Sahara, Mauretania, and the Sudan, and particularly the explorations of Capt. Augiéras who, in addition to various journeys in the Sahara between 1913 and 1917, crossed the desert with a small column in 1919–20 from Algeria to Senegal. This crossing, which is briefly described in an article accompanying the map, was from the French outpost of Tabelbala, south of Colomb Bechar, in a south-westerly direction to the outpost of Atar, whence by a circuitous route Bogue on the Senegal was reached. This entailed, from post to post, a total march by camel of some 1500 miles, which was accomplished, excluding rests, in 78 days. In such a survey there must obviously be inaccuracies and Capt. Augiéras regrets his inability to get more satisfactory longitudes, but the map shows great improvements on former maps of this part of the Sahara.

DISTRIBUTION OF ICE IN ARCTIC SEAS.—The publication by the Danish Meteorological Institute of "The State of the Ice in the Arctic Seas, 1922," directs attention to a somewhat unusual year, but unfortunately information is almost entirely lacking from Siberian waters and very scanty from the Beaufort Sea. By April the extent of pack in the Barents Sea was much smaller than usual. Bear Island, which had been free from ice all winter, was clear and open water almost reached to Novaya Zemlya. The edge of the ice continued to retreat. In July the whole west coast of Novaya Zemlya was clear, and in August Franz Josef Land was probably accessible by open sea. Early in the year conditions in Spitsbergen were about normal. In May and early June an unusual amount of ice drove round the South Cape before continuous easterly winds, but this resulted in the west coast being practically free from ice for the remainder of the summer. On the north coast conditions were particularly favourable, and a vessel reached lat. 81° 29′ N. Some sealers circumnavigated Spitsbergen, a feat that is not possible in most years. In the Greenland Sea the belt of pack lay more westerly than usual, and though the east coast of Greenland does not appear to have been clear of ice, open water touched the coast in about lat. 74° N. during August. Jan Mayen and the coast of Iceland were free from pack from May onwards throughout the summer. On the Newfoundland banks both pack and icebergs were abundant in early spring, but July was clearer than usual. In Davis Strait the winter ice was thinner and the "west ice" less abundant than usual. In Bering Strait conditions were fairly normal, but along the north coast of Alaska the pack pressed hard and navigation was much hindered.

EARLY HISTORY OF THE BLACK CURRANT.—The *Gardeners' Chronicle* has recently commenced a very interesting series of notes under the heading "Early Botanic Painters." In the issue of February 17, the figures of the Black Currant reproduced from the paintings by Jean Bourdichon (1457–? 1521) are extremely interesting, and raise the query whether the cultivation of the black currant may not be of longer date than is usually supposed. R. G. Halton of the East Malling Research Station has recently described existing varieties of the Black Currant, and to judge from his brief account of its early history (*Journal of Pomology*, vol i. No. 2, p. 68), it receives scant notice from the earlier chroniclers of horticultural effort.

A NEW CULTURE MEDIUM FOR BACTERIAL COUNT WORK.—For bacterial counting work, in which the plating method is used, a first essential of accuracy is that the medium used in plating should give uniform results. There are two respects in which a medium should display this uniformity. In the first place, it should be reproducible, that is to say, different batches of medium should give similar results. In a medium recently developed at Rothamsted (H. G. Thornton, *Annals of Applied Biology*, vol. ix. p. 241, 1923), this reproducibility has been achieved by using pure chemical compounds as food constituents and especially by selecting those compounds that were found not to alter the reaction of the medium during sterilisation. In the second place, parallel platings of a suspension of organisms made on a *single* batch of medium should develop the same number of colonies (within the limits of random sampling variance). Uniformity in this respect involves the independent development of each colony on the plate, and on agar media this is frequently prevented by the development of bacteria that form rapidly spreading colonies which interfere with the development of other bacteria. A special study was therefore made of a common "spreading" organism with a view of limiting its growth. It was found that the organism spread over the agar surface by active motility and that the factors controlling its spread were (1) the existence of a surface film of water on the agar, and (2) the rate of multiplication previous to the drying of this film. In the present medium this rate of multiplication has been much reduced, so that spreading colonies are greatly restricted.

SILKWORM DISEASES IN INDIA.—The subject of silkworm diseases is not a new one in India, but notwithstanding the fact that sericulture is probably a much older industry in that country than in Europe, there are no corresponding early records of disease. The whole problem is very fully discussed in a recent memoir by Dr. A. Pringle Jameson (Report on the Diseases of Silkworms in India, Calcutta, 1922. pp. 165 and 8 plates). It appears that all the recognised diseases are prevalent, and those of the mulberry, muga, and eri worms are the same. Pebrine is only of importance in mulberry worms: losses are still heavy, mainly because the majority of rearers use unexamined eggs or "seed." Muscardine is almost confined to mulberry worms and is a most serious complaint, whole rearings being frequently lost. Flacherie is of less importance in mulberry worms, while grasserie is stated to cause loss to all species. Conditions in India make the control of disease considerably more difficult than in temperate countries, but there is no reason why the industry should not be placed upon a surer footing. The crux of the whole question lies in the "ryot," and, if improvement is to be effected, the village rearer must be instructed as to the causes of disease and induced to go in for better methods of rearing. Since the industry is carried on by cottagers, the latter should be encouraged to use disease-free "seed." The extension of the Government nursery policy will avail little unless the rearer can be induced to educate himself to adopt better methods. The most important work of the Government sericultural officers should be instruction and supervision, while sericultural schools should be established. The sericultural department officials themselves should conduct research work on a practical scale, and an attempt should be made to provide them with the chief literature on this subject in order that they may keep abreast with sericultural research. Improvements are to be looked for from the work of the provincial sericultural departments being extended among the villages.

FIBRES FROM THE TROPICS.—A noticeable feature of journals recording activities in tropical agriculture is the interest at present being taken in the subject of fibre production. The *Tropical Agriculturalist*, issued from Peradeniya, records promising experiments with cotton, and in its December issue (1922) devotes considerable space to a paper by E. Mathieu, superintendent of the Government Plantation, Kuala Kangsar, upon the cultivation of the "Kapok" tree, *Eriodendron Anfractuosum*. In the fruits of this plant, hairs grow freely on the inner side of the valves of the capsule but not upon the seeds themselves, so that the separation of the fibre from the seed is a relatively easy matter. The export of this fibre from Java in 1912 exceeded 10,000 tons, and owing to the increasing demand from Europe and America, its cultivation seems likely to extend in Ceylon.

The same number of this journal has a note by A. P. Waldock upon the "akund" fibre, obtained from the shrubs *Calatropis gigantea* and *C. procera*, which the writer considers may have industrial possibilities as a village industry. In *Industrial India*, vol. i. No. 12, the possibilities are discussed of the "roselle" fibre, obtained from the bark of *Hibiscus Sadariffa*, particularly var. *Altissima*, which is said to have given good yields of fibre in Malaya, in regions with rainfall between 90 and 120 inches. For dry tropical regions there is "sisal," the fibre from the leaf of *Agave rigida*, var. *sisalana*. In *Tropical Life* for January Major L. A. Notcutt begins an interesting discussion of the possibilities of the cultivation and extraction of sisal, more particularly with reference to the problem whether the East African product may hope to compete with the Mexican in cost of production. At present our knowledge with all these fibre plants as to what conditions in cultivation favour maximum fibre development in the plant is entirely empirical, but such recent researches as those of Dr. W. L. Balls and H. A. Hancock (Proc. Roy. Soc., 93 B, 426-439, 1922) upon the growth of the cotton hair, and the numerous investigations upon cotton and flax, now being published in the Journal of the Textile Institute, arouse hopes that we may soon have a deeper insight into the problem of wall formation and thickening in the plant, and this should prove the first step towards the control of cultivation with the view of facilitating the formation of fibre.

FORAMINIFERAL SANDS IN CORSICA.—Messrs. E. Heron-Allen and A. Earland (Bull. Soc. Sci. hist. et nat. de la Corse, 1922, p. 100, Bastia) find that the red sands of the Gulf of Ajaccio, which were supposed to owe their colour to derivation from adjacent granite rocks, are in reality largely composed of foraminifera. Some ten per cent. of their volume is composed of the rose-pink *Polytrema miniaceum*, a species having a wide distribution in the Mediterranean, with which Mr. Heron-Allen was concerned in his recent report for the *Terra Nova* expedition. The authors, in an inserted fly-sheet, show that they have much cause to complain (as was remarked in the famous "Printers' Bible") that printers have persecuted them without cause.

DEPOSITION OF SILICA IN SEDIMENTARY ROCKS.—In such cases as the famous Devonian cherts of Rhynie, or the silicified forest of Arizona, geologists have urged the probability of an invasion of silica in solution from volcanic magmas. In suitable climatic conditions, however, much silica must be set free during laterising processes, and this may wander far from its original source. In the Proceedings of the Rhodesia Scientific Association, vol. 20, p. 9, 1922, Mr. H. B. Manfe records the interesting case of the silicification of a fairly recent freshwater shale at the base of the Kalahari Sands at Gwampa. Mr. T. B. Lawler of Princeton University (*Amer. Journ. Sci.*, vol. 205, p. 160, 1923) describes the sheets of chalcetory that traverse the Oligocene strata of S. Dakota, passing alike through the sands and the included fossils. He attributes the vertical cracks in which they have been deposited to the squeezing out of water during the settling down of the beds, as the humid conditions of Oligocene times in the Dakota area were succeeded by an arid climate in the Miocene period.

EARTHQUAKE PERIODICITY AND TIDAL STRESSES.—Recent numbers of the Bulletin of the Seismological Society of America (vol. 12, 1922, pp. 49-198) contain a memoir by Mr. Leo A. Cotton on earthquake periodicity with special reference to tidal stresses in the lithosphere. A welcome feature is the sympathetic examination of Perrey's neglected laws (of greater frequency about the syzygies, perigee, and the lunar passages of the meridian); the author considers that the first and second are supported by a high degree of probability, while the third is unsound. The second part of the memoir deals with the effects of tidal stresses in the earth's crust, with special reference to the geological aspects of the subject, such as the position of the originating faults. The author considers 316 world-shaking earthquakes from 1899 to 1903, and shows that earthquakes are more frequent when the sun or moon is near the horizon, and that there is a very high maximum of frequency when the sun and moon are so situated that they exert their tidal stresses in the same direction.

METEOROLOGY AT LIVERPOOL.—Results deduced from the meteorological observations taken at the Liverpool Observatory, Bidston, in the years 1920 and 1921, have recently been published by the Mersey Docks and Harbour Board. The report and discussion was prepared by Mr. W. E. Plummer, director of the observatory. Observations are supplied three times daily to the Meteorological Office, which also receives monthly and annual returns. Daily results are given for the two years and the total and means are grouped for each month and each year. For 1920 the mean atmospheric pressure was 29·942 in. (printed in error as 29·924 in.); the mean was above 30 in. in 5 months. The mean air temperature was 49·6° F., which is 0·5° F. above the normal, the absolute maximum was 78° F. and the minimum 21° F. The total rainfall was 33·34 in., which is 4·82 in. more than the normal; the duration of sunshine was 1257 hours, which is 222 hours less than the normal. For 1921 the mean barometric pressure was 30·045 in., which is more than a tenth of an inch higher than in 1920; in a similar report for Southport especial mention was made of the exceptionally high barometric pressure which characterised 1921. The mean at Liverpool was above 30 in. in 7 months. The mean air temperature was 51° F., which is 1·9° F. above the normal; the absolute maximum was 86° F. and the minimum 28° F. The total rainfall was 22·47 in., which is 5·95 in. less than the normal; the duration of sunshine was 1585 hours, which is 99 hours more than the normal. The general modification of scales for the several elements which is being uniformly adopted by the Meteorological Office is not as yet being followed at the Liverpool Observatory.

THE SCATTERING OF LIGHT BY LIQUIDS.—When a beam of ordinary light passes through a liquid its intensity gradually diminishes according to the exponential law owing to the scattering of the light by the molecules of the liquid. The light scattered in a direction transverse to the beam should be completely polarised. According to a paper in the March issue of the *Philosophical Magazine*, Prof. C. V. Raman and Mr. Rao have examined nine liquids to determine to what extent the theories of scattering are in agreement with the facts, and find that the Einstein-Smoluchowski theory is the most satisfactory. According to it the scattering should be proportional to the compressibility and absolute temperature of the liquid and inversely proportional to the fourth power of the wave-length of the light used. They find that the transverse light is only partially polarised, but, on applying the correction specified by Cabannes, which is due to the non-symmetrical molecules, the theory gives correctly the amount of the scattering. As the critical temperature of the liquid is approached, the scattering becomes very large and the polarisation of the scattered light more complete.

The Indian Science Congress.

THERE is a real danger that the severe retrenchment in public expenditure now in progress in India may lead to a curtailment of activities in those departments in which such restriction is least desirable, namely, the educational and scientific services devoted respectively to the training of workers and the investigation and development of the resources of the country. It was therefore very opportune that the presidential address delivered at the Indian Science Congress which has completed its tenth session at Lucknow (January 8-13) emphasised the danger of apathy towards scientific knowledge and the immense problems bearing upon the welfare of India still awaiting solution. The president, Sir M. Visvesvaraya, himself a distinguished engineer and for many years the successful administrator of one of the largest and most progressive of the Indian States, rightly laid stress on the appalling state of destitution in which quite 100 million out of the total population of 320 million in the country live, and the necessity for scientific research to increase the food supply, raise the standard of living, develop resources and train the people for citizenship. The address contained constructive suggestions towards stimulating research, promoting co-operation and concentration of effort and making the results of scientific work both in India and abroad more readily available.

The sectional presidents dealt with a variety of subjects and their addresses were mostly of a general character. A few words regarding each must suffice, and those who are interested will no doubt refer to the complete report which will before long be published by the Asiatic Society of Bengal. In his discourse to the Section of Physics and Mathematics, Dr. S. K. Banerji reviewed recent theories regarding the origin of cyclones and discussed in particular the cyclones of the Indian seas, their origin, movements and disappearance. He favoured the view that counter currents having their origin in differences in temperatures over large geographic areas initiate the conditions that give rise to a system of gyrating winds in these storms, and that the condensation of water vapour supplies the energy necessary to maintain them for a long period of time. Dr. Meldrum in a brief opening address to the Section of Chemistry made out a case for regarding the study of this subject as a liberalising influence.

Mrs. Howard in her address to the Botanical Section dealt with the rôle of plant physiology in agriculture and indicated a number of directions in which botanical research is desirable, such as the factors underlying high quality in agricultural produce, the scientific interpretation of field experiments, the precise nature of various agricultural practices which come under the head of mutilations, the relations between physiology and the incidence of disease, and the basis of acclimatisation and change of seed. It was suggested that investigators in the Indian universities would find in these subjects many problems of great scientific interest and practical importance.

Dr. Pillai in his address to the Section of Agriculture epitomised recent researches in soil science. Prof. G. Matthai gave the Section of Zoology a very interesting survey of recent oceanographical research, with special reference to the Indian Ocean, dealing very fully with the physical and chemical factors influencing marine life and its distribution. Especially noteworthy was the reference to recent work on the colour of the light that penetrates by transmission and scattering into the depths of clear ocean water and its possible influence on the coloration of marine fauna and the development of their powers of vision. In the Section of Geology, Dr. Pascoe dealt with the palæography of Burma. Major Acton discoursed on the aims and economic value of medical research to the section devoted to this subject. The importance and interest attaching to the study of cultural anthropology was well emphasised by Dr. J. J. Modi in the section over which he presided.

A general survey of the work of the Congress indicates that scientific investigations in India are to a considerable extent directed by the special needs of the country, and indeed perhaps even more attention should be given than at present to subjects such as the chemistry of Indian natural products and problems arising therefrom. As an example of the kind of work being accomplished at present in this direction may be mentioned an interesting paper by J. L. Simonsen and M. Gopala Rao in which they showed that an exceedingly small proportion of pyrogallol added to Indian turpentine inhibits its tendency to oxidation for some months and thus adds greatly to its value. The practical side of research was also emphasised in a symposium of the Sections of Agriculture, Botany and Chemistry, in which a whole morning was devoted to the discussion of the nitrogen problem in Indian agriculture, and in another joint meeting, of the Sections of Botany and Agriculture, devoted to the improvement of fodder and forage in India. The same tendency is also found strongly reflected in the proceedings of some of the sections, notably in those just mentioned and in the Section of Medical Research.

Fundamental research as distinguished from applied science was strongly represented in the physics section of the Congress, and this was largely owing to the influence of the Calcutta school which has grown up during the past few years. Among some of the papers which dealt with new fields of research may be mentioned one by Mr. K. Seshagiri Rao on the scattering of light in fluids at low temperatures. A remarkable fact elicited by recent work (see Proc. Roy. Soc., November 1922, p. 159) is that the light transversely scattered in liquids which at ordinary temperatures is very imperfectly polarised increases in intensity and at the same time becomes more and more completely polarised as the temperature is raised towards the critical point. In Mr. Seshagiri Rao's work, the study of the scattering is carried down to low temperatures, and an effect of the opposite kind is noticed. The quantitative results promise to throw light on the nature and magnitude of the thermal agitation of the molecules at low temperatures. An analogous investigation by Mr. Lalji Srivastava on the scattering of light in crystals was also presented to the Congress.

There is scarcely space to refer here in detail to the numerous other papers dealing with subjects so varied as vortex motion in fluids, formation of ripple-marks, earthquake coda, chromatic emulsions, acoustics of the pianoforte, whispering galleries, theory of band-spectra, temperature ionisation of gases, and α-ray tracks in argon and helium, to mention only a selection, presented to the section at Lucknow. A reference may, however, be made to a paper which evoked a most animated discussion at the meeting, that is one by the writer putting forward a new theory of the well-known blue colour of clear ice in glaciers (see NATURE, January 6). In reply to some of the points raised, attention was directed to the very remarkable fact that during the process of artificial crystallisation involved in the manufacture of ice, the suspended matter originally present in the water is rejected by the crystals as they form and accumulates in a pocket. Ice which shows the blue opalescence is quite free from colloidal matter of any kind.

C. V. RAMAN.

The Exploitation of the Sea.

TWO very important documents bearing on the subject of the rational exploitation of fishing grounds have recently become available. The first is the report to the Minister of Agriculture and Fisheries of the British delegates who attended the meeting of the International Council for the Exploration of the Sea, held at Copenhagen in September last. The other is the Report of the Danish Biological Station (xxix., 1922). Both papers are of very great interest.

The British official report emphasises the practical nature of the work of the Council and gives an account of its organisation. There are four sections (hydrography, plankton, statistics, and fish). The work of the fish section is carried out by committees, and those which deal with the investigation of the herring, cod and haddock, and of the biology of the Atlantic slope are of great interest to British workers. Programmes of the investigations adopted by these committees are given in the report. One important committee, that on the plaice fisheries, has now completed its work, and the recommendations made by it have been approved by the Council and are given in full. These are that the parts of the North Sea situated (1) between the Continental coast and the 12-fathom line from N. lats. 52° to 56°, and (2) between the 12-fathom and the 15-fathom line, be closed to steam trawlers and motor vessels of more than 50 h.p., the inner zone throughout the entire year and the outer one during the months July to March. No size-limits with respect to the fish caught are recommended. The Council recognises the difficulty of enforcing these measures without the sympathetic support of the fishing industry, but it regards this as a matter for the concern of the governments of the participating countries. It is considered that the adhesion of Germany to such a scheme of regulation will be essential. The Council advises the continuance of observations and the review of the whole proceedings after three years have elapsed.

The meaning of the impoverishment of a plaice fishing ground is examined by Dr. C. G. J. Petersen in the second of the reports noticed. Since 1893 this distinguished Danish zoologist has studied the fisheries in the Limfiord and in the adjacent seas. In 1893 the old styles of plaice fishing were superseded by newer and more efficient methods, and Dr. Petersen thought then that this meant "the end of the golden day for the fishing industry," and he had similar thoughts about the North Sea plaice fisheries. Now he confesses that later developments have shown that he was wrong. What has occurred in the two areas is much the same; the quantities of plaice taken per day's fishing by the old types of vessels were much greater than those now being taken by the newer boats fitted with much more efficient gear. Why? In both areas there was an "accumulated stock" of fish. Vessels of low fishing capacity could do well on such grounds.

How to remedy this "impoverishment"? There are two theories of regulation: (1) to raise more young plaice either by protecting the breeding fish so as to allow them to reproduce at least once in their lifetimes, or by artificial hatching, and (2) to legislate and otherwise deal with the fishery so as to increase the *growth-rate* of the plaice, because it is not merely a vast quantity of fish on the grounds that is desirable but rather an increased rate of production of plaice-flesh. An overcrowded ground may harbour small old plaice or young and relatively big ones. Plaice which do not grow at all consume from three to four times their own weight of food. In the Baltic there are fish of 32-36 cm. in length which are 4-5 years old as well as others of the same sizes but of 9-18 years old. The best policy is so to regulate the fishing as to increase the proportion of the younger, more rapidly-growing fish.

How to do this? The conditions in the North Sea illustrate the difficulty—and the remedy. If the Dogger Bank were an island surrounded by shallow water, vastly more plaice would grow to good marketable sizes than do now. As it is, the fishing is probably too intense and plaice are caught more rapidly than they can migrate out from the overcrowded grounds just off the Continental coasts. The restocking of the deeper parts, where the fish will grow well, from the nurseries (where they grow slowly) must keep pace with the depletion of these grounds. This means two kinds of measures: (1) size-limits in fishing, and (2) transplantation, both being modified according to the circumstances. If young plaice do not migrate out into favourable parts of the North Sea they must be assisted. Dr. Petersen himself made successful transplantation experiments in the Limfiord long ago, and more recently, English investigators have shown, beyond all doubt, that the same measures were practicable, and sure to be highly successful, in the North Sea.

The rationale of a continued and still more intensive exploitation of the fishing grounds is indicated by the scientific investigations. The transplantation experiments show which are the favourable grounds; growth-rates are known, and the work now in progress by the English investigators is giving results of value in regard to the supplies of food on the various grounds. The difficulties belong only to the practical working of the regulatory measures. Something like a scientific "nationalisation" of the deep-sea fishing industry appears to be necessary in the interest of an increased food supply, should the apprehensions of a failing stock be justified. It seems like a revolutionary proposal to suggest that permission to exploit the offshore fishing grounds should become necessary and that this permission should be accompanied by certain conditions, yet something of the kind may have to come in the near future. Meanwhile the scientific work in progress is affording the data whereby such proposals can materialise when the administrations are ready.

J. J.

Solar Radiation.

VOLUME IV. of the Annals of the Astrophysical Observatory of the Smithsonian Institution contains the investigations on solar radiation made by the director, Prof. C. G. Abbot, assisted by F. E. Fowle, L. B. Aldrich, and others. The work in the Northern Hemisphere has been transferred from Mt. Wilson to Mt. Harqua Hala, Arizona; that in Chile from Calama to Mt. Montezuma. In 1914 pyrheliometers were taken up to a height of 25 km. by small balloons. The atmospheric pressure was 3 cm. of mercury; the value of the solar constant indicated was 1·84 calories per cm.², in good agreement with the adopted value.

Mr. Clayton compared the variations of solar radiation measured in 1913–14 with the temperature records in various parts of the world; he found a correlation that was positive in the Tropics and Polar regions, negative in the Temperate zones. He also found that the temperature in Argentina was correlated to the short-period variations of radiation observed in Chile, and he suggests that these changes have a tendency to recur in periods of 12 and 22 days. They are interpreted as being due to varying transparency of the solar atmosphere. Measures of the brightness of Saturn indicated similar variations, but with a time-interval proportional to the difference of longitude of Saturn and earth. This would be explained by the solar regions of high or low radiation being carried round by the sun's rotation.

The excess of radiation at sunspot maximum is explained by the greater activity of solar convection currents at that time; these bring hot matter from the interior to the surface, which more than balances the loss of heat in the spots themselves.

The mean state of transparency of the solar atmosphere is measured by observations of the radiation at different distances from the centre of the disc. The contrast between centre and limbs is found to be greatest when the solar spot activity is greatest. On the other hand, the short-period increases of radiation are associated with less contrast between centre and limb.

The work also gives information on the transparency to radiation of different layers of our own atmosphere. "The atmosphere above 11 km. contributes more than half the radiation of the earth viewed as a planet. . . . Nearly the entire output of radiation of the earth to space, more than $\frac{9}{10}$, arises from the atmosphere and clouds."

The albedo of a large white cloud in the sunshine was measured from a balloon above it and found to be 78 per cent. Prof. H. N. Russell's discussion of Müller's observations of the albedo of Venus gave the value 59 per cent. It is concluded that the clouds on Venus while general are not thick enough to give full cloud reflection except for oblique rays. The albedo of the earth seen from space is estimated as between 43 and 45 per cent.

Botulism in Scotland.

THE Scottish Board of Health has issued a very clear and interesting report on the circumstances attending the deaths of eight persons from botulism at Loch Maree in Ross-shire last year, and none of the vivid tragedy of the occurrence is lost in the telling by Dr. G. R. Leighton.

On August 14, 1922, a number of guests stopping in the hotel went out for the day, and within a week six of them, as well as two of the attendant ghillies, were dead. Once some sort of food poisoning was suspected, the distribution of the fatalities between these living in the hotel and those living in their own homes in the neighbourhood at once implicated luncheon, the only meal taken in common, as the source of the poison, and further inquiries appeared to bring particular suspicion on a glass jar of wild-duck paste out of which about a dozen of the sandwiches had been made. The empty jar was fortunately recovered, and Mr. Bruce White, at the University of Bristol, was able to show that the small fragments of paste left in it were intensely poisonous to mice, and from them to isolate the *Bacillus botulinus* itself. One of the ghillies was not hungry enough to eat all his sandwiches and took one home with him, when he fell ill next day and rumour suggested something wrong with the lunch his friends buried the sandwich, which was retrieved later and shown by animal experiment to be extremely toxic. A guest also failed in his appetite and threw the most part of a sandwich to a wagtail on the lake shore; a month later Dr. Leighton found the decayed remains of a small bird among the stones.

There has, indeed, seldom been an outbreak of food poisoning in which the facts were so clear and so plainly verified. The only point of interest which the report fails to elucidate—and perhaps the facts could not be ascertained with complete accuracy—is how many people ate any of the poisonous paste without having symptoms: it seems likely that there may have been about five.

As has lately been shown by Dr. K. F. Meyer of the University of California (NATURE, January 20, p. 95) *B. botulinus* is a widespread common inhabitant of the soil, and may often be found on fruits, vegetables, and other food-stuffs. Taken with food in any numbers that are reasonably possible it is harmless, and in this way differs sharply from the food poisoning bacilli of the Gaertner and Aertrycke group, which multiply inside the body and cause illness by producing a definite infection. *B. botulinus* is poisonous only if it has been able to grow for some time under favourable conditions outside the body and produce large quantities of its potent toxin: man is poisoned by the toxin, not infected by the bacillus. Laboratory experiments show that the resting spores are exceptionally difficult to kill by heating. Considering, indeed, the wide distribution of the bacillus in Nature, the rarity of botulism is a remarkable testimony to the care with which potted meats and so on are usually prepared. Really efficient sterilisation is a secure preventive. The difficulty is that the glass containers, which the public æsthetically prefers, cannot be heated to a sufficiently high temperature without an undue proportion of breakages. There seems to be no good reason why they should not be prohibited and tins made compulsory.

Building Construction Research.

THREE reports on investigations connected with house construction and allied subjects have recently been issued by the Department of Scientific and Industrial Research.[1]

In the first of these, Mr. W. H. Wainwright gives some details of the cost of cottage building, and at the present time, when the cost of building is a very vexed subject and development schemes have to be very carefully debated owing to financial stringency, such information should be valuable. It is only by careful analysis in the matter of outlay that organisation can be improved and economy effected, and those engaged in large building works will find in these tables much interesting matter. The diagrams are partly compiled from data collected by the Ministry of Health; some are calculating graphics which should save time and do something to popularise graphic methods among technicians, while others show the rise and fall of prices in labour and materials from 1914 to 1922 and are of general application.

Mr. Weller in his editorial introduction anticipates

[1] Department of Scientific and Industrial Research. Building Research Board: Special Report No. 6, "A Graphical Cost Analysis of Cottage-Building." By W. H. Wainwright. Pp. iv+8+20 diagrams. 2s 6d. net. Building Research Board: Special Report No. 5, "Building in Cob and Pisé de Terre: a Collection of Notes from Various Sources on the Construction of Earth Walls." Pp. iv+40. 2s. net. Fuel Research Board: Special Report No. 4, "Tests on Ranges and Cooking Appliances." By A. H. Barker. An Extract from the Report of the Building Materials Research Committee. Pp. vi+55+15 figs. 2s. 6d. net. (London: H. M. Stationery Office, 1922.)

an obvious criticism that the basis of calculation may be of changing value owing to changed conditions by stating that the percentage cost of materials in a cottage in 1914 and 1921 was found practically identical. From the diagrams the increased cost of a cottage due to variation in the market price of a material can be at once ascertained. We imagine that variations in human output are a good deal less amenable to graphic representation. Apart from this, however, a great deal of useful matter on relative costs and methods of calculation will remain truly recorded in this publication.

The notes which constitute the report on cob and *pisé* building form an interesting epitome of a subject which came into great prominence during and after the war, when bricks were prohibitive in price and the bricklayer was laying them at a minimum rate never contemplated. It is very unlikely that the methods of building described will ever become general, though in special local circumstances they will continue to have value.

The contributors to these notes write quite dispassionately, a fact which adds greatly to the value of the concise information given. Various methods used are explained in detail with dimensioned sketches of the simple shuttering and tools used in this construction, while photographs of cob and *pisé* cottages show how satisfactory a home it is possible to produce, even for two-storied buildings, direct from natural earths. Walls, which may be of lumps from a mould or formed *in situ*, are one or two feet in thickness and the houses are said to enjoy a very equable temperature and to remain dry, but a brick or concrete foundation about a foot high is necessary. The recent times of stress have produced a great many new types of building, but if we are to judge from American experience it would seem that, taking capital and current cost over a decade, the ordinary brick still holds its own against later competitors.

Houses or cottages having been constructed, it is necessary to provide heating appliances, and range-makers and others will find much useful information in the third of these reports. The necessity for the conservation of fuel energy during the war provided the stimulus for this useful investigation. It is common knowledge that the kitchen range is, in most houses, the main and most wasteful coal consumer, and it is surprising that range-makers have not before now turned their attention to the production of more efficient designs. This may be due partly, as the author points out, to the incompatibility of running economy and initial low cost of apparatus, but if capital and current costs were simply tabulated the purchaser would soon realise the ultimate cheapness of a range designed to utilise more heat units.

The purposes of a range for boiling, baking, water heating, and perhaps warming, render, the report tells us, a really economical design impossible, and attention should therefore be directed to the consideration of any means for separating these functions which might be practicable at least in large establishments. These functions were tested independently both from a broad physical and also from a purely culinary standpoint. Considered as separate functions, only $2\frac{1}{2}$ per cent. of the heat is transmitted to the oven, 12 per cent. to heating water, and 1·5 per cent. to the hot plate, as an average for commercial ranges. These figures were very largely increased in appliances designed during the tests. It has been stated that market conditions preclude the commercial success of many improved types of range.

Diseases of Plants in England in 1920–21.[1]

By Dr. E. J. Butler, C.I.E.

Most countries in the civilised world have been forced within the last twenty years to take steps to protect their crops from the menace of foreign parasites. During that period, with the growing recognition of the aid that science can give to agriculture by studying the cause and control of plant diseases and pests, has come a great increase in knowledge of the dangers of unrestricted traffic in plants. Many instances have occurred to prove how real is the risk of introducing plant parasites from other countries and how difficult to guard against. America has been the chief sufferer, but it is sufficient to mention gooseberry mildew and wart disease of potato to show that England has not escaped. Distances, as measured in time and in the amenities of transport, are constantly contracting between the continents, and the interchange of living plants—with their parasites—goes on in ever-increasing volume. Quarantine restrictions, at first imposed in a few special cases, have extended until at present the exporting seedsman or nurseryman is faced with barriers to his trade which are often extremely hampering. It is easier for a human being to enter the United States to-day than for a potato, unless it is accompanied by a sheaf of health certificates; while total prohibition of certain categories of plants is not uncommon.

Correspondingly heavy responsibilities have fallen on the official plant pathologists of the various countries. Produce for export has to be inspected and certified, and imports from each country have to be scrutinised for possible dangers. As an essential foundation for efficiency in what may be called the "Plant Protection Service," it is obviously necessary to know what diseases already exist in one's own country and what may be introduced from each of the countries from which imports are received. Plant disease surveys have been developed in nearly all the more advanced countries, that of the United States being the most complete, as is natural in view of the vast interests involved. So far as the fungous diseases are concerned, it is to Mr. A. D. Cotton, mycologist to the Ministry of Agriculture, that is due the organisation of the English survey. The present report is the third of the series for which he has been responsible, and will be the last in view of his appointment as keeper of the Herbarium, Royal Botanic Gardens, Kew. It is also by far the most complete that has yet appeared and is second to none in any European country.

The report covers the two years 1920 and 1921. These years offered an extreme contrast in their meteorological features, and not the least valuable of the results of the survey is the way in which the differences in the two seasons are reflected in the incidence of particular diseases. Potato blight, a lover of cool and damp conditions, was rampant in 1920, but could not withstand the hot, dry summer of 1921. The attack of crown rust on oats in Wales was unprecedented in the former year and singularly slight in 1921. The mildews, on the other hand, were unusually bad in 1921, and common scab of potatoes,

[1] Ministry of Agriculture and Fisheries. Report on the Occurrence of Fungus, Bacterial and Allied Diseases on Crops in England and Wales for the years 1920–21. (Miscellaneous Publications, No. 38.) Pp. 104. (London: H.M. Stationery Office, 1922.) 3s. net.

a disease that has recently been shown to prefer warm soils, established a record in virulence.

One may hope that the accumulation of such facts (of which the report contains many), and their correlation with the weather charts which are attached, will enable trustworthy forecasts of the intensity of particular diseases to be issued. It is unnecessary to emphasise the practical value of this to the grower.

Another point of the highest practical interest, and one that is best brought out by the methodical records of a survey, is that of varietal resistance to specific diseases. Such a year as 1920 is invaluable in establishing the behaviour of different varieties of potatoes to blight under optimum conditions for the latter. Kerr's Pink, for example, appears at or near the top of nearly all the lists of blight-resistant potatoes that are also immune to wart disease.

Equally valuable are the records of new crop parasites. No less than 136 names have been added to this report as compared with that for 1919, and several of these are diseases not previously known to occur in the country.

The report deserves a wide circulation at home and abroad, as it presents in a handy and convenient form a remarkably complete summary of the fungous and allied troubles with which the British grower has to contend.

Wave-power Transmission.

AN interesting paper has recently been presented to the North-East Coast Institution of Engineers and Shipbuilders, by W. Dinwiddie, on wave-power transmission. Wave-power machines are classified under three heads: (1) Continuous waves, where the generating plunger moves with simple harmonic motion. (2) Impulse waves, in which a single harmonic motion is transmitted in wave form at regular intervals, greater than the period of the motion itself. (3) Sychronous and asychronous motors, monophase or polyphase, in which direction research is proceeding.

Liquids such as oils and water are at present the media used, while the transmission of impulse along a steel wire has been used. A reciprocating pump plunger of small stroke is oscillated at a high speed at one end of a closed pipe line. Waves of compression and expansion are propagated through the pipe line. If the pipe line is completely closed at the other end, very high pressures can be generated in the pipe line; but if a plunger similar to the pump plunger is placed there, this will move in synchronism with the pump plunger, and is therefore able to do work on some type of machine. To prevent excessive rise of pressure in the pipe line when the sychronising plunger is stopped, capacity analogous to a condenser in an electric circuit is put in the pipe line, and if all machines are cut off a stationary wave is formed and theoretically no energy is given to the system by the generator. It is desirable that connexions to machines along the pipe line shall be made at ½ wave-length points. Machines tapped in at half wave-length points along the pipe will be self-starting and stable in running, while those at the quarter wave-length and three-quarter wave-length will not be self-starting. If, however, a machine is started at half wave-length along the pipe, then a machine at a quarter wave-length will start; and if a machine is started at a wave-length along the pipe, then machines at a quarter and three-quarter wave-length will start. That this is so can be seen by examining the changes of pressure that take place at these points, when there is a stationary wave, and when there is a progressive wave superimposed on the stationary wave.

The principle has been successfully applied to controls on aeroplanes, to the working of rock-drilling machines, and to riveters. A description of the special transmission pipes to resist the high pressures generated, and the mechanism for rotating the rock drill, is given in the paper.

University and Educational Intelligence.

ABERDEEN.—The University Court has agreed to refit the Botanical Museum in Old Aberdeen, prior to the occupation of the new botanical department which is at present being built there. It has also agreed to make provision for increased laboratory accommodation for the department of chemistry.

CAMBRIDGE.—Mr. T. M. Cherry, Trinity College, has been elected to an Isaac Newton studentship, and the tenure of the studentship of Mr. W. M. H. Greaves, St. John's College, has been renewed for one year.

Smith's prizes have been awarded to Mr. J. C. Burkill, Trinity College, for an essay on "Functions of intervals and the problem of area," and to Mr. A. E. Ingham, Trinity College, for an essay on "Mean value theorems in the theory of the Riemann Zeta-Function." Rayleigh prizes have been awarded to Mr. E. F. Collingwood, Trinity College, for an essay on "The formal factorisation of an integral function of finite integral order," to Mr. W. R. Dean, Trinity College, for an essay on "The elastic stability of a plane plate," to Mr. E. C. Francis, Peterhouse, for an essay on "The Denjoy-Stieltjes integral," to Mr. C. G. F. James, Trinity College, for an essay on "The analytical representation of systems of space curves," and to Mr. M. H. A. Newman, St. John's College, for an essay "On discontinuities of functions of a single real variable."

The subject proposed for the Adams prize for the period 1923–4 is "The physical state of matter at high temperatures." Investigation is suggested of the statistical equilibrium of an assemblage of atoms in various ionised and quantised states together with free electrons and radiation. The essay may deal, however, in any way with the simplifications or the complications which appear in the properties of matter at high temperatures.

The Special Board for Oriental Studies will proceed to the election of the Eric Yarrow student in Assyriology early next term.

The Board of Research Studies in publishing its third report announces that the number of research students has risen to 179. Of these about two-thirds are working on the scientific side; chemistry and physics have the largest number, followed by botany, agriculture, and biochemistry.

Grants from the Gordon Wigan fund have been made to Prof. Punnett for plant-breeding experiments, to the Museum of Zoology for cases, to Prof. Gardiner for a centrifuge and incubator, to Mr. Harker for sections of rocks, and to Prof. Seward for sections of fossil plants.

DURHAM.—The council of Armstrong College, Newcastle-upon-Tyne, invite applications for the chair of philosophy. The latest date for the receipt of applications and testimonials is May 1. They should be sent to the Registrar.

LONDON.—The following doctorates have been conferred:—*Ph.D. in Science*: Mr. M. V. Gopalaswami of University College for a thesis entitled "Economy in Motor Learning"; Mr. A. M. Mosharrafa of King's College for a thesis entitled "The Quantum Theory of Spectral Series"; Mr. W. S. G. P.

Norris of the Imperial College (Royal College of Science) for a thesis entitled "The Formation and Stability of Spirane Hydrocarbons"; and Edith H. Usherwood of the Imperial College (Royal College of Science) for a thesis entitled "(i.) The Formation of Heterocyclic Rings involving Reactions with the Nitroso- and Nitro-groups in their various Tautomeric Modifications; (ii.) Experiments on the Detection of Equilibria in Gaseous Tautomeric Substances."

A post-graduate scholarship in science of the yearly value of 125*l.*, for two years, is being offered to Bedford College graduates for award in June next. Further information will be furnished upon application, by the Secretary of the College, Regent's Park, N.W.1.

Manchester.—Mr. R. S. Adamson has resigned his post as senior lecturer in botany on his appointment to the Harry Bolus chair of botany in the University of Cape Town.

Mr. C. R. Christian has been appointed temporary demonstrator in pathology.

The Court of Governors has authorised the conferment of the following honorary degrees: *D.Sc.*: Prof. Niels Bohr, Copenhagen; Prof. F. G. Hopkins, Cambridge; and Mr. W. B. Worthington, president of the Institution of Civil Engineers, 1921–1922.

We have received from the newly constituted University of Lithuania, Kaunas (Kovno), a copy of a bilingual—Lithuanian and English—calendar. The University, which was opened in February 1922, has the following faculties: theology and philosophy, humanities, law, mathematics and natural sciences, medicine, and technical science (engineering, chemical technology, architecture, etc.). It has 45 professors, 37 docents, and 35 members of the junior teaching staff, while there are more than a thousand students. It appeals to cultural institutions to help in the establishment of a library by sending books and other publications.

Loughborough College celebrated its first presentation day on March 10, when the College diploma was conferred on some 250 students of the following departments: mechanical and civil engineering (69), electrical (31), automobile (32), pure and applied science (10), commerce and economics (88), training of teachers (31). The Minister of Labour, Sir Montague Barlow, who presented the diplomas and gave an address, remarked that the College is carrying out a very interesting experiment in undertaking a course which combines very closely theoretical studies and practical experience. This feature, to which we directed attention in our issue of October 21, p. 562, aims at securing for engineering students advantages comparable with those which a School Hospital gives to medicals. An essential principle of management of the instructional factory is that the output should be saleable. During the war the College trained more than 2300 munition workers, and at its close inherited the fine buildings erected for this work as well as valuable engineering equipment. Among the post-war students have been more than 500 enrolled under the scheme of grants for higher education for ex-service students; 237 of them have taken the diploma, and of these 138 have been satisfactorily placed in employment. The number of private fee-paying students enrolled is 343. There are students from Australia, South Africa, India, and many foreign countries. The College aims at a normal enrolment sufficient to enable the productive work scheme to be carried on as a commercial and economic enterprise.

Societies and Academies.

London.

Royal Society, March 15.—J. A. **Carroll**: Note on the series-spectra of the aluminium sub-group. In contradistinction to the alkali metals, the highest terms in the known series-spectra of the elements of the aluminium sub-group are the common limits of the sharp and diffuse series, and not the limits of the principal series. Measurements of the ionisation and resonance potentials for thallium suggested that there might be a yet undiscovered principal series in the far ultra-violet, the limit of which would be the greatest term and would correspond with the normal state of the thallium atom. Against this is the absence of positive evidence of such a series, and the easily reversible nature of the lines of the subordinate series in the arc spectra. Evidence as to the normal state of the atoms is afforded by an investigation of the absorption spectrum of the cool vapour of one of the elements in question, *e.g.* thallium. The lines were members of the subordinate series, thus confirming the original series arrangement. The results accord with the latest developments of Bohr's theory.—W. E. **Curtis**: The structure of the band spectrum of helium.—II. Seven of the doublet bands previously examined by Fowler have been studied in detail. The structure of the bands, in the main, is in agreement with the requirements of the quantum theory; some discrepancies are discussed in connexion with Kratzer's half-quantum hypothesis. Values for the moments of inertia of the molecules concerned are derived by a graphic method. Several perturbations are recorded (the first examples in this spectrum) and their significance is discussed.—G. C. **Steward**: Aberration diffraction effects. Diffraction theory would indicate that the image of a luminous point, given by a symmetrical optical system, should be a system of luminous rings, and this was investigated by Airy in 1834; geometrical theory leads to a consideration of several types and orders of aberration, and the modification of the "ideal" diffraction pattern produced by these geometrical aberrations is discussed. The method adopted depends upon the Eikonal function of Bruns. Aberration diffraction effects are dealt with, assuming that the stops of the optical system are circular, with centres upon the axis of symmetry. Other stops used, namely, the usual circular aperture, but with the central portion stopped out, one (or two parallel) narrow rectangular aperture, and a semi-circular aperture are also considered.—Lord **Rayleigh**: Further observations on the spectrum of the night sky. Specially designed spectrographs having a working aperture of $f/\cdot 9$ are described. The northern and southern horizons have been photographed simultaneously on the same plate, and the aurora line recorded almost down to the horizontal direction in each. There is no marked difference of intensity between them. The negative nitrogen bands appear fairly often in photographs taken in the north of England, but similar spectra taken in the south of England do not show them. They are always strong in the Northern Lights in Shetland. Two bright lines or bands in the blue and violet were always observed, the approximate positions, determined on the *very* small scale spectra, being 4200 and 4435. Their origin is not known. In addition, there is the aurora line 5578, also of unknown origin, and the dark Fraunhofer lines H and K.—Lord **Rayleigh**: Studies of iridescent colour, and the structure producing it. IV.—Iridescent beetles. Some of the iridescent beetles which have striking metallic colours show band systems in the spectrum of the reflected light.

That from *Pelidnota sumptuosa* shows a central maximum bordered on either side by subordinate maxima in exactly the way that reflection from a uniformly spaced assemblage of 34 thin plates would require. In the spectrum from one of the golden beetles, *Callodes parvulus*, the bands are accounted for on the supposition of two assemblages, each consisting of several reflecting planes, the distance between the assemblages being about 8μ.—J. W. **Nicholson**: Oblate spheroidal harmonics and their applications.—J. W. **Nicholson** and F. J. **Cheshire**: On the theory and testing of right-angled prisms.—J. C. **McLennan** and D. S. **Ainslie**: On the fluorescence and channelled absorption spectra of caesium and other alkali elements. Caesium exhibits a fluorescence and a channelled absorption spectrum in the neighbourhood of $\lambda = 8000$ when the vapour of the element is traversed by white light. In the absorption spectrum, bands separated by intervals that were simple multiples of 24 Å were found. Like sodium, potassium exhibits channellings in its absorption spectrum, in the neighbourhood of the second member of its doublet series. Indications have been obtained of channelling in the absorption spectrum of lithium in the near ultra-violet region.—W. **Stiles**: The indicator method for the determination of coefficients of diffusion in gels, with special reference to the diffusion of chlorides. The coefficient of diffusion increases at a greater rate per degree rise in temperature the higher the temperature; the relation between coefficient of diffusion and temperature in gels is thus not linear as is usually assumed for free diffusion in water. The coefficient of diffusion decreases with increasing concentration of gel and increases with decreasing concentration of the diffusing salt. Empirical expressions are given for these relationships.—H. T. **Flint**: A generalised vector analysis of four dimensions. An account is given of an invariant vector calculus in a notation which is the natural generalisation of that of Gibbs. Contravariant and covariant vectors are related by means of an operator—the extended idem-factor, and tensors are introduced as dyadics and polyadics. The expressions familiar in the tensor calculus of Riemann and Christoffel appear very simply in the analysis. Separated points are connected by the geodetics, and a simple definition of parallelism at two points leads at once to the Weyl parallel displacement relations.

Geological Society, February 28.—Prof. A. C. Seward, president, and, afterwards, Prof. W. W. Watts, vice-president, in the chair.—S. Hazzledine **Warren**: (1) The late glacial stage of the Lea Valley (Third Report). One new section found occurred at the level of, and in the area occupied by, the Middle or Taplow Terrace, whereas all the other sections were in the Low Terrace. It consisted of a bed of seed-bearing clay, in the middle of an old gravel-pit partly built over. The Taplow deposits yield a fairly temperate fauna and flora. The site is close to the head of a small streamlet, and it is assumed that the Arctic plant-bed is of Low-Terrace or Ponders-End date, and that it represents the silting of a stream which flowed across the Taplow Terrace. According to a report on the Arctic flora by Mrs. E. M. Reid and Miss M. E. J. Chandler, there is nothing to distinguish the flora from that of the previously-described localities of the Lea Valley. (2) The *Elephas-antiquus* bed of Clacton-on-Sea (Essex), and its flora and fauna. The deposit fills a deep, narrow, steep-sided, river-channel which apparently flowed into the Thames when that river occupied the deep channel now submerged off the coast of Essex. The Clacton bed yields evidence of an abundant flint-industry which is one of the best-known representatives of the Mesvinian series. This is of Late Chellean or Early Acheulean date, although it shows no cultural connexion with those industries, but it may be the precursor of Mousterian. The deposit is also rich in mammalian remains. Appended to the paper are detailed reports on the palæontology.

Linnean Society, March 1.—Dr. A. Smith Woodward, president, in the chair.—J. N. **Halbert**: Notes on the Acari, with descriptions of new species.—C. F. M. **Swynnerton**: Aspects of African woodland formations. Rain-forest, coppice, and thicket due to grass-fires, the means of prevention from injury by such fires, and the preservation of the forests by careful nurture, were dealt with.

Aristotelian Society, March 5.—Prof. A. N. Whitehead, president, in the chair.—E. S. **Russell**: Psychobiology. Physico-chemical method is applicable to many of the phenomena of life, but it fails of complete success because it cannot take account of the individuality and striving of the living thing, nor its flexibility of response. Also it cannot take into consideration, as an active factor, the past history of the organism, for it must regard past history as completely summed up in present state. The true alternative to the materialistic view is not vitalism, but a psychobiological view based upon a monadistic philosophy. Both the movements and the morphogenetic responses of the organism must on this view be interpreted as actions of a living individuality, carried out in response to its own sensed environment, in pursuance of the fundamental conative impulses which are the core of its being.

Zoological Society, March 6.—Sir S. F. Harmer, vice-president, in the chair.—Mr. **Caldwell**: A case of apparent melanism in Tippelskirch's Giraffe (*Giraffa camelopardalis tippelskirchi*).—H. G. **Cannon**: A note on the zoæa of the land-crab, *Cardisoma armatum*.—Miss L. E. **Cheesman**: Notes on the pairing of the land-crab, *Cardisoma armatum*.—C. F. **Sonntag**: The comparative anatomy of the tongues of the mammalia.—VIII. Carnivora.—T. H. **Ring**: The elephant-seals of Kerguelen Land.—R. **Kirkpatrick**: On the tunicate *Rhizomolgula globularis* Pallas. No. 24. Results of the Oxford University Expedition to Spitsbergen, 1921.

Society of Public Analysts, March 7.—Mr. P. A. Ellis Richards, president, in the chair.—A. **Lucas**: The examination of firearms and projectiles. A particular weapon may sometimes be recognised by the rifling marks imprinted on a bullet, while the nature of the fouling left in the barrel after the weapon has been fired may afford information as to the nature of the original powder and also, in some cases, the period that has elapsed since the last discharge. The composition, dimensions, and markings on bullets, slugs, etc., are described, and directions are given for the reproduction of rifling marks and for the chemical analysis of projectiles.—R. C. **Frederick**: The interpretation of the results obtained in the analysis of potable waters.—S. B. **Phillips**: Determination of the purity of vanillin. After reviewing the various methods proposed from time to time the author described two processes for estimating vanillin—one volumetric, and the other gravimetric.

Edinburgh.

Royal Society, March 5.—Prof. F. O. Bower, president, in the chair.—F. O. **Bower**: The relation of size to the elaboration of form and structure of the vascular tracts in primitive plants. Measurements of the diameters of the whole part (stem or petiole) and of the conducting tract (stele or meristele) in many living and fossil plants show that increasing size is accompanied by increasing complexity of structure. There is a tendency in the various organs of plants to decentralise their conducting tracts as the part enlarges, and to advance them in greater or less degree towards the periphery of the transverse section. This decentralisation is carried out homoplastically, with details differing in the several parts affected, in various primitive organisms. It is not inherent in any one organ. The final result may be a convergence of structure in different plants, and in different parts of the same plant. This is illustrated (i.) by the solenostele, (ii.) by the zygopterid petiole, (iii.) by the Dipterid petiole, (iv.) by the petiole of Anachoropteris. Stellation of the stele or of the xylem, medullation, decentralisation of the stele, and finally its disintegration, so far as they are functions of increasing size, must lose grade for comparative purposes.—Miss Margery **Knight**: The life history and cytology of *Pylaiella litoralis*. Development and the reproductive processes were described. This involved a detailed cytological study of the organism. In particular it is shown that there is no obligate relationship between cytological features, somatic characters, and reproductive organs. The object of the paper is to emphasise this fact, and thereby to reopen discussion on the value of cytological characters in phyletic study.—A. **Steuart**: An electric clock, with detached pendulum and continuous motion. The speed of the driving electric motor is controlled by a pendulum, without throwing any work on the latter. A gravity arm acts on the pendulum, and then short-circuits a resistance in the motor armature circuit. The motor raises the gravity arm, and so replaces the resistance. A powerful turret clock and a silent regulator clock were demonstrated.

SHEFFIELD.

Society of Glass Technology, February 21.—Prof. W. E. S. Turner, president, in the chair.—W. W. **Warren**: Organising for production from pot furnaces. The function of a furnace is to melt glass. For most purposes, circular gas furnaces, either regenerative or recuperative, are to be preferred to those of rectangular shape. Among the advantages of working to a time-table in the matter of founding and working during definite periods are: (*a*) the responsibility devolved on the producer and furnacemen to have glass ready in time for their co-workers; (*b*) mixing, filling pots, and all labour subsidiary to glass-making work smoothly in an appointed groove. Informal talks with the men's committee, with a blackboard for illustrating points and explaining figures, rarely failed to convince them that foreign competitors' methods and prices were a challenge to business sport. But if there were rewards at the end of the production programme, the men must share.—F. W. **Hodkin** and Prof. W. E. S. **Turner**: The effect of boric oxide on the melting and working of glass.—Violet **Dimbleby**, S. **English**, and Prof. W. E. S. **Turner**: Some physical properties of boric oxide-containing glasses. Prof. Turner presented these two papers. The new British chemical glass, American pyrex glass for chemical ware and cooking ware, and various forms of illuminating glasses, all contain boric oxide. Although the addition of boric oxide to a silicate glass brought a marked increase in the durability, this beneficial effect only holds good up to a certain point. Similar inversions in other properties, *e.g.* in the thermal expansion, the annealing temperature, the density, and refractive index, had also been found.

Official Publications Received.

Imperial Earthquake Investigation Committee. Seismological Notes No. 3: The Semi-Destructive Earthquake of April 26, 1922. By F. Omori. Pp. 30+18 plates. (Tokyo.)

The Carnegie Foundation for the Advancement of Teaching. Seventeenth Annual Report of the President and of the Treasurer. Pp. vii+211. (New York.)

Annual Report of the Department of Fisheries, Bengal, for the Year ending 31st March 1922. Pp. iii+8+2. (Calcutta: Bengal Secretariat Book Depot.) 4 annas.

Lick Observatory Bulletin No. 343: An Investigation of the Spectra of Visual Double Stars. By Frederick C. Leonard. Pp. 169-194. (Mount Hamilton, California.)

State of California: Fish and Game Commission. Twenty-seventh Biennial Report for the Years 1920-1922. Pp. 139. (Sacramento: California State Printing Office.)

Shirley Institute Memoirs. Vol. 1, 1922. Pp. v+174. (Didsbury, Manchester: Shirley Institute.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 10, Part 5: Experimental Studies on the Developing Eggs. By T. Inukai. 1: Age and Environment in Amphibia. Pp. 107-140+2 plates. Vol. 10, Part 6: Spectro-Chemical Studies on some Biochemical Color Reactions. By Tetsutaro Tadokoro. Pp. 141-189+6 plates. (Tokyo: Maruzen Co. Ltd.)

University of London: University College. Report of the University College Committee (February 1922-February 1923) with Financial Statements (for the Session 1921-22) and other Documents for Presentation to the Senate. Pp. 104. (London: Printed by Taylor and Francis.)

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ending June 30, 1922. Pp. 210. (Washington: Government Printing Office.)

Diary of Societies.

SATURDAY, MARCH 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (6).

MONDAY, MARCH 26.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. J. J. B. Coles: Relativity and Christian Philosophy.

INSTITUTE OF ACTUARIES, at 5.—P. N. Harvey: The Scheme of National Health Insurance considered in relation to the Valuations of Approved Societies as at December 31, 1918.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—J. H. Mummery and B. Grellier: Multiple Dentigerous Cysts.—Mrs. Mellanby: Diet, Dental Structure and Caries.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—C. Christy: The Waterways of the Sudd Region, Bahr el Ghazal.

TUESDAY, MARCH 27.

ROYAL SOCIETY OF MEDICINE (Medicine Section) (at St. Bartholomew's Hospital), at 5.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Sir Frank Baines: The History and Repair of the Roof of Westminster Hall.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—P. J. Waldram and J. M. Waldram: Window Design and the Measurement and Predetermination of Daylight Illumination.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. W. Barthold: The Nomads of Central Asia.

WEDNESDAY, MARCH 28.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. E. Greenly: Further Researches on the Succession and Metamorphism in the Mona Complex.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.—Demonstrations and Exhibits:—J. W. Atha and Co.: The New Zeiss Photographic Eye-piece, "Phoku."—J. H. Barton: A New Research Microscope of Original Design.—R. and J. Beck, Ltd.: A Microscope specially suitable for the Examination of Large Surfaces of Paper and of Prints and Engravings.—The Edison Swan Electric Co. Ltd.: The Ediswan Pointolite Lamp, 30, 100, 500, and 1000 c.p. in Operation; The Working of the Alternating Current Pointolite Lamp.—Ogilvy and Co.: A New Stereoscopic Magnifier giving Large Field of View and Long Working Distance.—M. P. Swift: Professor Shand's Recording Micrometer which is designed to facilitate the Quantitative Estimation of Minerals in Rocks.—At 8.—J. Strachan: The Manufacture of Containers and Papers used for the Wrapping of Foodstuffs.—H. B. Wrighton: The Microscope in Metallurgical Research.—S. R. Wycherley: Microscopy in the Examination of Manufactured Paper.

PUBLIC LECTURE.

SATURDAY, MARCH 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. A. Cunnington: The Natural History of Lobsters and Prawns.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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National Health and Medical Research.[1]

THE elaborately detailed report of the Medical Research Council for the past year gives much food for thought, whether we receive it in the spirit of the tax-payer, anxious to be assured that his contribution to the national health is being worthily expended, or in the spirit of the watchman, eager only for a sign, but untroubled by detail. We all have in us something of the tax-payer and, let us hope, something more of the watchman, so let us see how these respective parts of us are catered for in the Council's report. Whether we are able to appreciate its contents or not, we, as tax-payers, have always demanded this sort of governmental report. Does it not concern the disbursement of 130,000*l.*, or something like a halfpenny per head of the population, on the pursuit of new knowledge that is to alleviate human suffering? Unthinking lay and even medical critics might regard it as a perilous investment. Were they holders of cinema shares, they would probably accept without question a similar disbursement to the parents of a Jackie Coogan.

If, then, we expect to find definite assurance that new knowledge leading directly and immediately to improvement in the health of the community has been acquired, we shall be disappointed. The average newspaper, keen only for sensation, would vote it dull. But a closer study of the report, including its admirable introductory chapter by the special Committee of the Privy Council, is calculated to bring to the more responsive of us the conviction that inability to appreciate springs from our own ignorance and short-sightedness. We gather, in fact, that the machine which registers advance in scientific medicine resembles a piece of complicated clockwork, the wheels of which represent movements in all the biological and physical sciences, not excluding mathematics. We note, for example, how the Hill katathermometer—an instrument of precision for measuring the cooling power of the atmosphere—may be made to afford a most valuable index of conditions affecting the efficiency of the worker in factory and workshop. We note also recent progress in our knowledge of the biological action of sunlight, and its remarkable influence on diseases such as rickets. A new field is here opened.

The discovery of insulin by the Toronto workers is alluded to at length. We gather that a method of preparing a potent product of consistent uniformity has not yet been achieved, but doubtless this difficulty will yield to further research. It is worth reflecting that this new knowledge might still be withheld from us, were it not for the elaboration in recent years of

[1] Report of the Medical Research Council for the year 1921–22. (Published by His Majesty's Stationery Office.) 3*s.* 6*d.* net.

quantitative tests for sugar in the blood. It is probable that many a preparation of pancreas has failed, in the past, to become established because its physiological activity could not be satisfactorily tested and recourse was limited to casual clinical trials. When one considers the plethora of commercial pancreatic preparations already on the market, which claim to contain the specific sugar-destroying principle, it is comforting to know that the Medical Research Council has taken the action it has, and that its own experts are actively engaged in studying methods that may yield preparations of uniform potency. In connexion with these difficulties, we note with some interest Dudley's work at the National Institute in refining pituitary extract. Apparently, the further the purification was carried, the less potent the substance became physiologically. This is not the first time that such stumbling-blocks have interfered with attempts to refine biologically potent principles contained in organ extracts or in culture fluids which have served for the growth of micro-organisms.

It would be superfluous to attempt to enumerate the many lines along which research is being pursued, either by expert workers at the National Institute or by the many outside specialists whose work the Medical Research Council encourages or finances; nor can we mention even the terms of reference of the numerous committees and sub-committees which have taken upon themselves the task of co-ordinating attack upon a multitude of problems in all fields of scientific medicine and hygiene. Membership of these committees is no sinecure, and it is notorious that much self-denying work is performed. Verily, the appreciative tax-payer can have no reason to grumble at the way in which his exiguous contribution to the community's health is expended.

Now what has the report to say to the watchman seeking for a sign? We believe the organisation of research under the ægis of a responsible body of scientific advisors is a valuable national asset. Will such organisation interfere with the individual freedom of the research worker? Is there a danger that the extension of the team-principle and the laying down by a higher authority of precise research programmes may stifle what originality the worker may possess? The answer is, we believe, that there are men who work best in a team and men who prefer to work alone, and that there is ample room for both types. There are periods both in war and in peace when stocktaking of knowledge is essential if we are again to make advance into the unknown. The present is one of those times of national stocktaking in medical science. The very fundamentals of many departments of medical science require revision. A doyen of the chemical world recently referred to certain developments and proposals in biological chemistry as being simply re-search, with the accent and insistence on the first syllable.

The statement is both true and false. Simple reconstruction must inevitably form an integral part of modern research. Possibly the biological sciences, on which advance in scientific medicine mainly hangs, contain a greater proportion of inexact, un-coordinated, and incomplete statement than the so-called exact physical sciences. Every advance in the latter reacts on biology, necessitating re-search in some form or other. Co-ordinated investigation by teams is necessary in peace as in war, and the fruit will duly appear. The scientific investigation of deficiency diseases—a war-time necessity—has developed into something like a science of its own. The organised investigations on anærobic bacteria—another war-time necessity—which was perhaps a very typical example of a re-search, has already borne abundant fruit in recent exact studies of such diseases as botulism and braxy.

What of the night? The morning cometh.

J. C. G. L.

The Fourier-Bessel Function.

(1) *A Treatise on Bessel Functions and their Applications to Physics.* By Prof. A. Gray and G. B. Mathews. Second edition prepared by A. Gray and Dr. T. M. MacRobert. Pp. xiv+327. (London: Macmillan and Co., Ltd., 1922.) 36*s.* net.

(2) *A Treatise on the Theory of Bessel Functions.* By Prof. G. N. Watson. Pp. viii+804. (Cambridge: At the University Press, 1922.) 70*s.* net.

THE function to which these volumes are devoted received its name from the astronomer Bessel, 1824, on introducing it for the coefficients in the expansion of radius vector, and true or eccentric anomaly in a Fourier series of sines and cosines of multiples of mean anomaly or time. Two years before, in 1822, Fourier had encountered the same function essentially in his analytical theory of heat, and his variable is the square of the variable of Bessel.

The function is, however, first met in a dynamical problem, of the oscillation of a vertical chain, investigated by Bernoulli, 1738, and here the Fourier form is the natural one to use. The oscillation is replaced by a steady motion of permanent shape in a chain hanging down, and revolving bodily, and this is easy to realise experimentally; the plane oscillation is then seen in the shadow on a vertical wall.

Take the condition of relative equilibrium of a length x above the lowest point, where it is assumed that the displacement is small enough for vertical distance x

and the length of the chain to be undistinguishable, so that the tension $T=\sigma x$, as at rest, σ the line density.

Putting $g=\omega^2 l$, where l is the height of the equivalent conical pendulum revolving at the same rate ω, the equation of relative equilibrium is

$$T\frac{dy}{dx}+\int\sigma\frac{y}{l}dx=0,\quad x\frac{d^2y}{dx^2}+\frac{dy}{dx}+\frac{y}{l}=0,$$

having a solution $y=b\mathrm{F}(x/l)$, where $\mathrm{F}(x)$ is Fourier's function, defined by the series

$$\mathrm{F}(x)=\Sigma\frac{(-x)^k}{(\Pi k)^2}.$$

The sort called *Furniture Chain* is suitable for experiment: the links are small hollow brass spheres, joined up by rivet links, and it is sold in various sizes.

A length of the large size of about 4 feet is suitable for whirling round by hand, and producing a curve in 1, 2, 3, 4, . . . waves, showing to the eye the position of the first roots of $\mathrm{F}(x)=0$.

Standing up on a chair or the table, a length of 8 or 12 feet of the smaller size may be set in rotation by the dynamobile toy. The chain springs at once into a series of waves, where the higher roots are seen and their spacing, prolongation of the figure at the end of Gray.

The chain can also be used to show off a real catenary curve, instead of the string recommended in Routh—much too kinky and destitute of flexibility to form a good catenary. And dropping the chain from a height is a good problem on a steady blow, equivalent of a series of impacts of the discrete links.

With a rotating chain of variable density, σx^n, the tension $T=\sigma x^{n+1}/(n+1)$, and the equation changes to

$$T\frac{dy}{dx}+\int\sigma x^n\frac{y}{l}dx=0,\quad x\frac{d^2y}{dx^2}+(n+1)\frac{dy}{dx}+(n+1)\frac{y}{l}=0,$$

the solution of which may be written

$$y=b\left(-\frac{d}{dx}\right)^n\mathrm{F}(n+1)\frac{x}{l},$$

and l is the length of the subtangent at the lowest point.

For if $u=\mathrm{F}(x)$ is the solution of the equation

$$x\frac{d^2u}{dx^2}+\frac{du}{dx}+u=0,$$

differentiating n times, with $y=(-d/dx)^n u=\mathrm{F}_n(x)$,

$$x\frac{d^2y}{dx^2}+(n+1)\frac{dy}{dx}+y=0,\quad y=\mathrm{F}_n(x)=\Sigma\frac{(-x)^k}{\Pi(n+k)\Pi k},$$

the Fourier function of the nth order.

Here n may be changed into $-n$, and the differentiation into an integration, making $\mathrm{F}_{-n}(x)=x^n\mathrm{F}_n(x)$.

Gray's function $\mathrm{I}_n(t)$ (p. 20) is the equivalent of $\mathrm{F}_n(-x)$.

But with the variable $z=2\sqrt{x}$ of the Bessel form, the equation changes to

$$z^2\frac{d^2y}{dz^2}+(2n+1)z\frac{dy}{dz}+z^2y=0,$$

and this, with $y=(\tfrac{1}{2}z)^{-n}u$, into

$$z^2\frac{d^2u}{dz^2}+z\frac{du}{dz}+(z^2-n^2)u=0,$$

defining $u=\mathrm{J}_n(z)=(\tfrac{1}{2}z)^n\mathrm{F}_n(\tfrac{1}{4}z^2)$, and the simplicity disappears of the derivation of $\mathrm{J}_n(z)$ from $\mathrm{J}_0(z)$ by successive differentiation or integration; factors intervene of powers of z.

The interlacing of the roots of F_n and F_{n+1} is evident from the differentiation; and there is an infinite series of positive roots, but none are negative.

This chain of variable density could be imitated by a flexible lattice blind, of appropriate curvilinear outline, hanging vertically, and rotating bodily.

Lecornu's problem of the oscillation of a large weight, raised or lowered by a chain of which the density may be neglected, is seen in operation in the erection of the tall buildings springing up around; it gives rise to similar expressions.

A Fourier function of fractional order arises in the question of the stability of a tall mast or tree, or of a chimney stalk when it begins to flinch on the foundation, and starts to curl over from the vertical; illustrated experimentally by a thin steel wire clamped in a vice.

With uniform cross-section, the equation is

$$ek^2\frac{d^2p}{dx^2}+xp=0,\quad \frac{1}{p}\frac{d^2p}{dx^2}+\frac{x}{ek^2}=0,$$

where $p=dy/dx$, k is the radius of gyration of the horizontal section across the plane of flexure, and e is Young's elastic length of the material, quotient of the modulus of elasticity divided by the density.

Every linear differential equation of the second order is reducible, by a change of independent and dependent variable, to the canonical form

$$\frac{1}{u}\frac{d^2u}{dx^2}+\mathrm{I}=0,$$

and when the differential invariant $\mathrm{I}=kx^n$, any power of x, the form to which Riccati's equation is reducible, the equation is reduced to Fourier's form by a mere change of the independent variable to

$$z=\frac{kx^{m+2}}{(m+2)^2},$$

and becomes Fourier's equation for

$$u=\mathrm{F}_n(z),\quad n=-\frac{1}{m+2}$$

(Watson, p. 88).

Here with the uniform column on the verge of drooping from the vertical, $m=1$, $p=b\mathrm{F}_{-\frac{1}{3}}(x^3/9ek^2)$.

The smallest root of $F_{-\frac{1}{3}}=0$ is about 0·88, say $\frac{8}{9}$ (Watson); this makes the critical height

$$x=2(ek^2)^{\frac{1}{3}}=(\tfrac{1}{2}ed^2)^{\frac{1}{3}}$$

for a circular rod of diameter d.

For steel, we may take $e=250$ million cm, one quarter of a quadrant Q of the Earth, $\sqrt[3]{\tfrac{1}{2}e}=500$.

With a steel wire held in the vice vertical, one millimetre in diameter, $d=0{\cdot}1$ cm, the critical height $x=500\,d^{\frac{2}{3}}=107{\cdot}7$ cm, a little over one metre. As the height is increased through this length, the vibration becomes sluggish more and more, and finally ceases, and the wire droops.

The drooping of a candle on a hot day will give an illustration; also a field of corn when it is ripe, where, to obtain a complete solution, the weight of the head would require the introduction of the Fourier function of the second kind, or a Bessel-Neumann-Weber function (Gray, p. 14; Watson, p. 308); so too for the addition of a weight at the end of the vibrating chain.

Here the flexural elasticity keeps the rod, mast, or cornstalk vertical; a flexible chain cannot be made to stand upright; the sign of x would be changed in the relation, and the Fourier function has no negative root.

But a quasi-rigidity can be imparted, as in the reported rope trick of the Indian juggler magician, if our chain carries a gyroscopic flywheel in rapid rotation inside each link, like a pile of spinning tops, and then, as shown in *Phil. Mag.*, Nov. 1919, p. 506, the differential equation of the former result changes to the form

$$(a-x)\frac{d^2y}{dx^2}-\frac{dy}{dx}+\frac{y}{l}=0,$$

with x measured downward from the free end at the top; the solution is

$$y=b\mathrm{F}\left(\frac{a-x}{l}\right),$$

and the first value of $y=0$ is given by $(a-x)/l=1{\cdot}44$. Thus a length x of the gyroscopic chain can be made to stand upright, given by $x=a-1{\cdot}44\,l$.

The whip and whirl of a revolving shaft has become a question of practical importance in the swift-running machinery of a turbine, internal-combustion flying-machine motor, and gyro-compass.

Here it is obvious that the shaft will depart from the straight form when the revolutions are equal to the lateral vibrations of the shaft at rest, held between the same bearings, the disturbing and restoring force being the same in the two cases.

The more general form of the differential equation, required when the cross-section and density varies as some power of x, will be

$$\frac{d}{dx}\left(x^q\frac{dy}{dx}\right)+kx^my=0,$$

and hence a change to the independent variable

$$z=\frac{kx^{m-q+2}}{(m-q+2)^2}$$

will lead to Fourier's equation of order

$$n=\frac{q-1}{m-q+2}.$$

The general solution of Riccati's equation is thus expressed by the Fourier function; and the condition that Riccati should have a solution in finite terms requires n to be half an odd integer.

Beginning with $n=-\frac{1}{2}$,

$$\mathrm{F}_{-\frac{1}{2}}(x)=\Sigma\frac{(-x)^k}{\Pi(k-\frac{1}{2})\Pi k},$$

$$\mathrm{F}_{-\frac{1}{2}}(x)=\frac{1}{\sqrt{\pi}}\Sigma\frac{(-2\sqrt{x})^{2k}}{\Pi 2k}=\frac{\cos 2\sqrt{x}}{\sqrt{\pi}};$$

and a phase angle ϵ may be added to the variable $2\sqrt{x}$ to include both forms of the function.

Then the other Fourier functions of order half an odd integer are derived by an integration or differentiation with respect to x:

$$\sqrt{\pi}\mathrm{F}_{\frac{1}{2}}(x)=-\frac{d}{dx}\sqrt{\pi}\mathrm{F}_{-\frac{1}{2}}(x)=\frac{\sin 2\sqrt{x}}{\sqrt{x}},$$

$$\sqrt{\pi}\mathrm{F}_{\frac{3}{2}}(x)=-\frac{\cos 2\sqrt{x}}{x}+\frac{\sin 2\sqrt{x}}{2x^{\frac{3}{2}}}=x^{-\frac{3}{2}}\sqrt{\pi}\mathrm{F}_{-\frac{3}{2}}(x),$$

and so on.

The same simplicity of derivation is not so obvious in the table (Gray, p. 17) for $J_{n+\frac{1}{2}}(z)$, although the sines and cosines are replaced by sin, cos $(z+\epsilon)$.

Functions of this fractional order are of frequent occurrence in mathematical physics, as in the vibration of a sphere (Love's "Elasticity," Lamb's "Hydrodynamics") for the functions ψ_n and Ψ_n, solution of $(\nabla^2+m^2)\phi=0$, in the propagation of spherical waves or the conduction of heat; also for the function F_n of Bromwich and $\gamma\rho$ of Macdonald in electromagnetic waves; simplicity would be obtained if all these functions were referred to the Fourier form and classed there (*Phil. Mag.*, Nov. 1919, pp. 508, 526).

The Fourier function comes in useful for the discussion of a long flat tidal wave in an estuary or channel of vertical cross-section K, and surface breadth b, treated as slowly variable, on the assumption of K and b varying as x^q and x^m, simple powers of x.

The Fourier function is suitable, too, in the discussion of diffraction (Gray, Chapter XIV.), provided the area of a circular fringe is taken in the formula instead of the circumference or diameter.

The derivation, by differentiation and integration, of the Fourier function of different order marks it out as more appropriate than Bessel for the passage, in Lord Rayleigh's manner, of the tesseral harmonic $P_n^k(\mu)$ direct into a Fourier function $F_p(x=\frac{1}{4}m^2r^2)$ as the order

n is increased indefinitely (*Phil. Mag.*, Nov. 1919, p. 526).

In Gray's treatise the physical applications are kept in view throughout the book up to the end. The requirements are considered of the mixed mathematician. Not to start with general theory, but to give definite technical examples, to show how the problem may be reduced to the differential equation considered, he will consult the appropriate part of the book as the need arises, and will take for granted the discussion of details of pure analysis, on the validity of an expansion, definite integral expressions, asymptotic expansions, and all the niceties appealing to the pure mathematician of a logical metaphysical intellect.

These can be skipped by the physical student engrossed in a physical problem, and only anxious to dig out the facts and apply the formula to a concrete numerical application, for which the tables at the end of the book will give the requisite material.

The treatise of Watson has a different scope. A first short historical chapter cites name and date of the pioneers up to 1826 encountering the function in dynamical, astronomical, and heat problems, namely, Bernoulli, Euler, Fourier, Bessel.

After this introduction, all definite mention of the physical application is dismissed by Watson in the subsequent 800 pages, and the reader is not encouraged to lift his eye from the page and look up at any materialisation of the analysis, or to study a geometrical picture.

The book proceeds in what is now the conventional manner of a modern analytical treatise, stopping in a leisurely manner to emphasise and scrutinise every possible objection that may arise on the part of rigour. Those who like this work become uncommonly fond of it, and lose interest in a realisation of the ideas.

"Making possible the necessary degree of abstraction is one of the most important merits of mathematical logic."

The Bessel function has few attractive analytical qualities, and does not deserve elaborate treatment to the exclusion of more valuable interest, say of the elliptic function.

The students must be few to afford the time demanded for this subject, not to speak of the expense—for Watson's book, 70*s.*; and Gray's of 327 pages, at 36*s.*

We see the tax laid on knowledge by the price of all mathematical work; the expense of publication has risen far beyond anything contemplated in the old days of debate in the Mutual Improvement Society on the need of a free press and cheap diffusion of knowledge.

It is the fashion to-day to discard a redundant *i* in the name Bernoulli, as in the Bernoullianum Mathematical Museum in Basel, Basle, Bâle in Switzerland. But Maclaurin in his "Account of Newton's Philosophical Discoveries," 1750, spells the name Bernovilli, and here we see the etymological derivation and a reason for the restoration of the banished *i*.

G. GREENHILL.

A Yearbook of the Learned World.

Index Generalis: Annuaire général des Universités, Grandes Écoles, Académies, Archives, Bibliothèques, Instituts scientifiques, Jardins botaniques et zoologiques, Musées, Observatoires, Sociétés savantes. Published under the direction of Dr. R. de Montessus de Ballore. Pp. 2111. (Paris: Gauthier-Villars et Cie, 1923.) 35*s.*

WE welcome the appearance of the third (1922–23) issue of a work which, pending the issue of "Minerva" in its old form, is the only comprehensive directory of the learned world. Its scope is shown by the following analysis of its 2111 pages: (1) Directories of universities, colleges, and professional schools grouped by countries, 913 pages; (2) astronomical observatories, 86 pages; (3) libraries and archives, 325 pages; (4) museums and scientific institutes, 100 pages; (5) learned societies and academies, 194 pages; (6) list of *savants* who desire to exchange original dissertations with their fellow-workers, 7 pages; (7) index of names (more than 40,000), 428 pages; (8) other indexes and vocabularies, 53 pages. In part (1), in addition to the names of professors, lecturers, and other teachers and their subjects, are mentioned the principal administrative officers and, in many cases, the date of foundation, the total number of students, and the total annual expenditure: in part (2), publications, principal instruments, and programme of work; in part (3), days and hours of admission and annual holidays, date of foundation, special features, number of volumes, MSS., etc., annual budget, catalogues, rules for borrowers, name of librarian; in part (4), similar particulars with general description of exhibits or plant and mention of publications; in part (5), objects and aims, number of members, date of foundation, names of president and secretary, subscription, particulars of meetings, lists of fellows and of foreign members of some of the more important societies, and details of publications.

The editing of such an enormous mass of data is a formidable task and Prof. R. de Montessus de Ballore, the distinguished scholar who has had the courage to undertake it and the energy and perseverance to complete it, has thereby earned the gratitude of *savants* of all countries. The editor, who states that his object has been to achieve "the utmost clearness for reference," is to be congratulated on his judicious selection of type and on the ingenious device whereby he refers in the index of names not only to the page but to the particular section of the page in which the name sought is to be found.

The most generally useful part of the book, on the merits of which it will be judged, is part (1), and we have therefore examined some of the entries in this part, selected at random, in order to test its general accuracy. In such a work absolute accuracy is unattainable, but the editor, aiming at a high standard, "thought it better not to publish any information except such as has been directly communicated by administrative chief officials. . . . He has further had the proof of each entry corrected by its contributor." He has branded with an asterisk the rather numerous institutions which have failed to reply to his questionnaires in time and has reproduced the notices of them which appeared in the 1920–21 issue: thirty-one institutions which have not replied since 1919 have been excluded altogether. This procedure unfortunately has not prevented what we cannot but regard as an excessive percentage of error in the entries tested.

We venture to offer a suggestion regarding the entries in part (1) relating to institutions in the British Empire—about one-third of the total number. It is that the editor might use as the basis of such entries the Yearbook issued by the Universities Bureau of the British Empire. Had he done so he would not have omitted such important institutions as the Osmania University of Hyderabad, Deccan, the University of Rangoon, the University of Patna (except for casual references), and University College, Swansea, his entries would have been more rather than less up-to-date, he would have saved himself a great deal of labour and expense, and would have been saved from such "howlers" as *His Grace* Eamon de Valera (Chancellor of the N.U.I.) and showing (and indexing) Petro Drilling as the name of a teacher instead of showing it as a subject (petroleum well-boring).

There is, moreover, another and a very important side to the question. If our university administrative officials, after having supplied returns to their own Universities Bureau and to Government Departments, are to be plied with requests for the self-same information in different forms for international Indexes and the League of Nations (which now proposes itself to compile something of the kind), it will not be surprising if some of the answers are short or if the pages of the Index become even more abundantly starred than at present. If the universities of each country would combine to produce a national yearbook, these would make the best possible material for (if not constituent parts of) an Index Generalis. For the British Empire the work is already done. Italy has her "Annuario degli Istituti Scientifici"—not yet appearing annually, however. The American Council on Education is, in its recently formed Division of College and University Personnel, acquiring much of the requisite material for such a yearbook, and Switzerland and the Netherlands have similar inter-university organisations.

The Cactus Family.

The Cactaceae: Descriptions and Illustrations of Plants of the Cactus family. By N. L. Britton and J. N. Rose. Vol. 3, pp. vii + 255, with 24 plates. (Washington: Carnegie Institution, 1922.)

ALL who grow Cacti will be glad to learn that the third volume of this fine work has been issued. It will probably appeal to a larger number of Cactus fanciers than the two preceding volumes, because it treats chiefly of the smaller kinds, which are more generally cultivated than the columnar or climbing species. This volume is of the same high standard of excellence as the two others, and as an account was given in NATURE of July 7, 1921 (vol. 107, p. 580) of the general character, scope, and details of the work, it will be unnecessary to repeat them here.

The subtribes dealt with in this volume are the Echinocereanæ, consisting of 6 genera (3 of them new) and 115 species, the largest genera being Echinocereus, 60 species, and Echinopsis, 28 species. The Echinocactanæ consist of 28 genera (18 of them new) and 166 species, the largest genera being Ferocactus, 30 species, Malacocarpus, 29 species, Gymnocalycium, 23 species, and Echinofossulocactus, 22 species. The Cactanæ consist of the two genera Discocactus, 7 species, and Cactus (better known as Melocactus), 18 species. Altogether 36 genera (of which 17 are monotypic and 21 are new) and 306 species are described, and well illustrated by 250 figures in the text, and 24 plates, most of them coloured.

Most of the Echinocactanæ are known to cultivators as belonging to the genus Echinocactus, and they will perhaps find it difficult to understand why, in this volume, only 9 species are placed under that genus, and all the others relegated to other genera. The reason is that while the vegetative characters of a large number of species is similar in type, the structural details of their flowers differ, and these floral differences have, in this work, been utilised for generic distinction in a manner not practised before. All this is made manifest in the keys, which are concise and clear, so that with the aid of the very numerous illustrations few should find difficulty in referring an unnamed species of the group to its proper genus.

It is much to be deplored that such a cumbersome sentence-like name as "Echinofossulocactus" should have been brought into use, but unfortunately there seems no valid reason for its rejection, for although it has been overlooked, it was proposed and characterised 81 years ago. It would, however, be of benefit to horticulturists and botanists alike, if, at the next Botanical Congress, a law could be made to prohibit the formation of such atrocious names in future.

The charming coloured plates give a good idea of the beauty of the flowers of these prickly plants, and the views showing some of them as they grow wild will convey to the mind of the cultivator the appearance they should have when well cultivated. Of the plants figured, *Ferocactus rectispinus* is one of the most striking on account of the formidable aspect it presents by its stout straight spines about 4 inches long. Of all the flowers figured the most remarkable is that of *Denmosa rhodacantha* (better known as *Echinopsis rhodacantha*), which is curved in a sigmoid manner, and has the petals closed tightly around the exserted stamens and style, quite unlike that of any other genus.

The well-known spineless *Echinocactus Williamsii* is rightly removed from that genus and now forms a monotypic genus under the name of *Lophophora Williamsii*. This plant has remarkable narcotic properties and has long been used by certain tribes of North American Indians in some of their ceremonies. One peculiarity of this plant is that its stamens are irritable, and when touched at the basal part they rapidly close in around the style, dusting their pollen upon the insect or other thing that touched them; an evident means of securing cross-fertilisation. A very full index completes the volume. There remain to complete the work the subtribes to which the genera Mammillaria and Rhipsalis belong.

N. E. BROWN.

Our Bookshelf.

Kinematograph Studio Technique. (Technical Primers.) By L. C. Macbean. Pp. xii + 111. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

ACCORDING to the subtitle of this little book, it is "a practical outline of the artistic and technical work in the production of film plays for producers, cameramen, artistes, and others engaged in or desirous of entering the kinematograph industry." There are chapters on production, the camera and its lenses, studio lighting and outdoor work, dark-room procedure, and so on. No previous knowledge of the subject is assumed, and many will be interested to learn of the artifices by which some of the more striking film scenes are produced, while they may also be surprised at the amount of painstaking labour and attention to detail which goes to the making of a successful film.

The Chemistry of Dental Materials. By Prof. C. S. Gibson. Pp. 176. (London: Benn Bros., Ltd., 1922.) 12*s.* 6*d.* net.

A CAREFULLY selected area in chemistry, largely metallurgy, is dealt with in this treatise, but what is done appears thorough. The treatment is not narrow and utilitarian, but as scientific as is possible. The second half of the book deals with miscellaneous materials used in dentistry, such as porcelain, cements, abrasive materials and antiseptics, and in this, of course, much information is given which cannot be found in the ordinary text-books of chemistry. The Brunner-Mond process for zinc, described on p. 100, is said to be now obsolete, and the same applies to the third form of tin (p. 105). Some mention of modern processes for lead extraction might have been given. Davy's name is incorrectly given on p. 146.

(1) *Installations électriques industrielles: Installation—Entretien—Contrôle.* Par R. Cabaud. (Bibliothèque Professionnelle.) Pp. 333. (Paris: J. B. Baillière et fils, 1922.) 10 francs net.

(2) *Alternating Current Electrical Engineering.* By P. Kemp. Second edition. Pp. xi + 515. (London: Macmillan and Co., Ltd., 1922.) 17*s.* net.

(1) THE first part of M. Cabaud's book deals in a general way with electric installations for light and power. The numerical examples given will be helpful to the practical engineer. The maintenance of an installation is discussed in the second part, and in the third part methods of control are described. Various methods of penalising consumers who take their supply at a low-power factor are given.

(2) The principal changes in the new edition of Mr. Kemp's book are a new chapter on the protection of alternating current systems, and a number of alterations in the chapters on instruments.

The Radio Amateur's Hand Book. By A. F. Collins. Pp. xix + 329 + 8 plates. (London, Calcutta, and Sydney: G. G. Harrap and Co., Ltd., 1922.) 7*s.* 6*d.* net.

A POPULAR description of radio communication which will be helpful to amateurs is given in this book. The author uses the proper technical terms, so any one who has read this book will be in a position to benefit by more advanced treatises on the subject. In the glossary, however, the attempt to define highly technical terms in the simplest language is of doubtful utility. Capacity is defined as "any object that will retain a charge of electricity." The book concludes with a long list of radio "don'ts," which will prove instructive to the beginner.

The Pupils' Class-book of Geography: the Americas. By Ed. J. S. Lay. Pp. 176. (London: Macmillan and Co., Ltd., 1922.) 1*s.* 3*d.*

IT is not easy to write an elementary text-book on geography which has any interest for the pupils who use it and at the same time is truly geographical, but Mr. Lay appears to have succeeded. His book is accurate, readable, and well illustrated by excellent black and white maps, and presents the essential features of the geography of the Americas.

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.*]

The Nature of the Liquid State.

IN his recent lecture to the Chemical Society on "The Significance of Crystal Structure," Sir William Bragg has described and discussed the extremely important results obtained in his laboratory by the X-ray analysis of various carbon compounds, notably those belonging to the aromatic series. The special feature brought to light by the investigations is that the ultimate unit of crystal structure or elementary parallelepiped is not the chemical molecule, but, generally speaking, is a complex formed by the union of two, three, or four molecules. Further, the symmetry of the crystal tends to increase with the number of molecules in the unit, and also with the symmetry of the molecule itself. In fact, there are simple quantitative rules, first stated by Shearer, connecting these quantities.

The question naturally arises whether when a crystal is melted and passes into the liquid state, the units in the latter condition are the same as in the crystal, or whether these break up further into the individual molecules. A method of investigating this very fundamental point is furnished by studies on the molecular scattering of light. If the units in the liquid state are the chemical molecules, that is, the same as in the condition of vapour, there should be a simple quantitative relation between the amount of *unpolarised light* (due to optical anisotropy) scattered by equal volumes of liquid and vapour and the densities in the two states of aggregation. This relation was indicated in my letter in NATURE of July 1, 1922, but the method of calculation there given has to be amended to make allowance for the fact that the electric polarisation within a fluid is, according to the Lorentz-Mosotti formula, greater than in free space. When this correction is made, it is found that the amount of *unpolarised* light actually scattered is considerably smaller than that indicated by the calculation. The conclusion thus appears to be forced upon us that the ultimate unit in the liquid state is not the same as in the state of vapour. On the other hand, if we adopt the view that the ultimate unit is the same in the liquid state as in the crystalline state, a way is opened for a satisfactory explanation of the observed result. For, according to Shearer's rule, the symmetry of the unit is always greater than that of the molecule, and hence the amount of unpolarised light scattered by it should be diminished, as is actually observed.

A further consideration which suggests that the ultimate unit in the liquid state is the same as in the crystalline solid is the existence of those remarkable substances, known as liquid crystals, studied by Lehmann and others. If a liquid be conceived of as a collection of elementary crystal parallelepipeds which are ordinarily prevented from thermal agitation from forming regular arrays, it is easier to understand how in favourable circumstances, such arrays come into existence temporarily and as quickly disappear. This conception appears to fit in very well with the mathematical framework of the kinetic theory of liquid crystals recently developed by Oseen (Stockholm Academy, Handlingar, 1921).

The same conception also appears to furnish a satisfactory explanation of the tendency shown by many liquids to refuse crystallisation and to pass into a highly viscous or glassy condition when supercooled. We have only to suppose that the units gradually join up, but in an irregular way, and form an optically heterogeneous structure. This conception of the constitution of vitreous solids is supported by the results of an extensive series of observations on the scattering of light in optical glasses and in supercooled organic liquids carried out under the writer's direction.

Finally, it may be remarked that the conception suggested does not, so far as the writer can see, appear to be inconsistent with any other known facts regarding the physical properties of liquids.

C. V. RAMAN.

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February 22.

PROF. RAMAN'S very interesting explanation of his observations on the scattering of light by liquids is not affected if a slight change is made in his suggestion as to the appearance of the crystal unit in the liquid phase.

The crystal unit is a parallelepiped of minimum volume, the corners of which are occupied by molecules alike in all respects, including orientation. The definition allows the unit to be delimited in an indefinite number of ways. It is improbable that any one of these occurs as the only kind of unit in the liquid. For Prof. Raman's purpose it is sufficient, I think, to suppose that association, when it occurs, is ordered, the molecules joining up as if they were beginning to build a crystal. Let us suppose, for example, that the crystal belongs to the monoclinic prismatic class, in which there are four types of molecular arrangement. Any molecule of one type possesses with any molecule of the other three types, a plane, a digonal axis, or a centre of symmetry, respectively.

Groups of mutually arranged molecules may well be expected to form under suitable conditions, but it is not likely that the group will always consist of four, or be put together the same way. The group could always, however, be incorporated into a complete crystal: possibly some redressing of the boundary might be required.

An ordered association or incipient crystallisation has been suggested by Astbury (Proc. Roy. Soc., 102, p. 527) as the cause of the variability of the optical activity of tartaric acid with the strength of solution. The Debye-Scherrer photographs of colloidal gold show that each particle is essentially an association of gold atoms in crystalline array. It is possible that on the surface there is disorder which affects the further growth of the particle.

The point is that whenever association takes place, it tends to do so in the ordered fashion of the appropriate crystal. W. H. BRAGG.

The Wegener Hypothesis and the Great Pyramid.

IN the discussions on the Wegener hypothesis I have not yet seen an allusion to the direct evidence given by Flinders Petrie ("Pyramids and Temples of Gizeh," second edition, 1885, pp. 11 and 41) of a change in azimuth at Gizeh amounting to four or five minutes since the erection of the Great Pyramid.

Petrie's account of the high accuracy used in the construction of the pyramid seems to render quite impossible an error of 4′ in the laying down of a meridian line 700 feet long, from which other baselines were set off during 30 or 40 years. As my brother, Lt.-Col. M. M. Bidder, pointed out to me, every annual class in the local school of engineers would, in its turn, verify the meridian line under the supervision of their instructors; yet the second pyramid has the same orientation ($5\frac{1}{2}'$ west of north) as the core-plane of the first pyramid.

There are five meridians deduced by Petrie (p. 41) from his measurements. Of these the lowest and highest values occur in the Great Pyramid, being $-3' 43'' \pm 6''$ for the casing sides and $-5' 49'' \pm 7''$ for the passage. The four of them representing the Great Pyramid core and passage, and the Second Pyramid casing and passage, are all covered by the value $-5' 33'' \pm 17''$. Petrie's conclusion (p. 11) is "that the original base was probably more accurate than 0·05 inch in length and 12″ in angle."

GEORGE P. BIDDER.

Cambridge, February 26.

THE undoubted trend of the pyramids at 4600 B.C. was about 5′ west of the present pole. Each of the data was probably set out afresh from polar observation, as that would be easier than transfer by measurement. The accuracy of work there to 12″ of angle is in keeping with the accuracy of later work, as of granite planes 20 square feet in area with only inch/160 error at 3300 B.C., or of weights in eighth century A.D. with variations all within grain/200. The cause of a change of axis of about 5″ per century might be due to ocean currents or to earth deformation.

W. M. F. PETRIE.

Science and Armaments.

DR. FRENCH'S reply (NATURE, February 10) to my letter in the issue of January 20 does not touch upon the essential idea which I desired to express. I did not raise the question of the dispensability or indispensability of armaments at the present moment: a question on which a great deal might be said, but one which, I think, is somewhat outside the province of NATURE. The very columns of this journal are, however, a witness to a very real international brotherhood between men of all lands who find a common interest in the study of natural science and in its ceaseless warfare for the knowledge and control of material things for the common good of humanity.

Taking the wider view, how can it be a *consolation* that, under the urge of apparent national expediency, men should be spending their time in devising new methods of warfare by the application of that knowledge and training which should be a blessing to mankind instead of a curse? The new weapon used against A by B is to-morrow directed by A against B. Moreover, these methods, the scientific cleverness and interest of which often provide a poor mask for their brutality, are directed, not against barbarism, but largely against those for whom we now profess friendship. Such a condition may be difficult to avoid, but the great danger is that we should treat it as natural and inevitable, and grow insensible to the shame of these things. Have we forgotten the folly of

"All valiant dust that builds on dust"?

In the time of Davy it seems clear that science was respected as a thing apart from war, and we are led to inquire the reason for the change. Has it not been the willingness of inventors to exploit their knowledge, and to allow themselves to be exploited by men who cared less than nothing for science and all that it really stands for? There was small patriotism in many transactions that might be recalled, for things were sold to the highest bidder.

My first letter was, in brief, a plea that we should treat our science as something rare and precious, belonging not to ourselves only but also to all nations. Whatever burdensome and unpleasant tasks it may fall to our national lot to perform, we shall not face them the less effectively because we keep some of our most cherished possessions free from the dust of conflict. Hence my comment on the proposed action at the Science Museum. L. C. MARTIN.

Royal College of Science,
South Kensington, S.W.7.

Hafnium and Titanium.

REFERRING to Sir Edward Thorpe's interesting letter on this subject in NATURE of February 24, I would point out that the Cornish village of "Manaccan" is in the parish of Manaccan, which adjoins the parish of St. Keverne. There is an error also in the spelling. "Menaccan" should be M*a*naccan, and so with the stream at "Lenarth," it should be *L*anarth. Presumably, therefore, the Cornish mineral should have been called M*a*naccanite and not M*e*naccanite, and the "new element" from it should have been termed "manachin" and not "menachin."

WILSON L. FOX.

Falmouth, February 26.

The Cause of Anticyclones.

IN a letter to NATURE of December 23 (vol. 110, p. 845) Mr. W. H. Dines has raised certain questions connected with the cause of anticyclones. The chief observational facts to be explained are the features peculiar to *most* high pressures, namely, the warm troposphere, the high and cold stratosphere. But not all anticyclones are warm even from a height of 3 km. up to 8 km. Some are cold to considerable heights. The gradual rise of the coefficient of correlation between pressure and temperature at the same level as one proceeds from 0 to 4 km., and the comparative uniformity of the coefficient from 4 to 8 km., is in itself strong evidence that in our latitudes these first 4 km. are the theatre of changes of air more and more frequent as the surface is approached, and that in the regions above 4 km. the air is nearly always of one sort as regards its origin. Again, with regard to persistence, Hanslik pointed out that only the "warm" anticyclones are steady and slow moving; the "cold" ones move quickly. Further facts to be taken into account are, that the conception of an anticyclone as a region of great vertical stability and of fine bright weather appears to be correct as a rule only for the "warm" anticyclone. In the other type anything short of violent weather conditions may be experienced.

I have recently (Q. J. Roy. Met. Soc., January 1923) put forward some evidence in support of the view that the explanation of the temperature peculiarities of the high- and low-pressure systems of our latitudes is, to a large extent, contained in the Bjerknes theory of their origin. In particular, when a pocket is made in the polar front by the southward rush of a great patch of polar air and when the pocket is afterwards closed behind this patch by the equatorial current from the south-west, the result is the formation of an anticyclone with closed isobars. From an examination of a more or less continuous series of upper-air observations I endeavoured to show that in such cases the change in barometric pressure at a given spot in the British Isles was indeed brought about by the fact that a thickness $h + \delta h$ of polar air had replaced a thickness h of the equatorial current, and that the upper layers of the equatorial current appeared to have been raised unchanged through the height δh. Provided that the polar air was not more than 2 or 3 km. in depth, anticyclones formed in this way would be "warm" anticyclones, and would possess the features associated with such. But there are almost certainly cases where the encroaching polar air extends right up to the base of the stratosphere, and these appear to have all the characteristics of the cold, rapidly-moving anticyclone. This cold air, passing as it does into latitudes warmer than those where it acquired the main features of its existing temperature distribution, is heated from the bottom upwards, and becomes sufficiently unstable to provide within itself moderate rain and much cloud, but probably not persistent heavy rain. (It seems likely also that anticyclones do reach us in which there is either no polar surface air or only a negligible amount. Their formation was probably a much more gradual though similar process, and took place in more southerly latitudes.)

Mr. Dines has referred to the difficulty of maintaining the polar air *in situ*. The patch of polar air with which we are dealing may be described as a roughly circular one of 1000 or more km. in diameter; in the case of a "warm" anticyclone we may limit its depth at the deepest part to 2 or 3 km.; in the case of a "cold" anticyclone the depth in the centre may include the whole thickness of the troposphere. It appears to be maintained *in situ, so far as it is maintained*, by the currents which produced it. But actually the motion of most "cold" anticyclones—*i.e.* those of the deep polar air—does strongly resemble that of the flat drop of mercury on the laboratory table.

This problem was dealt with hydrodynamically by Exner in 1918 (*Sitzungsber. Akad. Wiss.*, Wien IIa, 127, 1918, pp. 795-847). He assumed as the initial conditions the existence of a mass of cold dense air (at rest or in motion) covering a small portion of the earth's surface and surrounded on all sides and above by warmer, less dense air. Particular points made by him include—(1) that the rotation of the earth renders possible the maintenance (at a slight inclination to the horizon) of a definite fixed bounding surface between the cold and the warm air; (2) that if a long ridge of cold air divides into two ridges flowing apart like cold waves, then the square of the velocity of separation of these waves is proportional to the depth of the cold air and to the difference of density between the cold and the warm; (3) also that in such a case friction with the earth's surface results in a shallow cold film being left over the whole area traversed by the waves and in the consequent gradual reduction in the height of the waves.

There is another consideration which supports the view that an anticyclone is of complex structure, and that is the frequency with which the air above an "inversion" of temperature can be shown to be of different origin from that below. It has usually been said that the surface layers were being cooled by radiation, also that there was outflow of air in these layers, and that the upper air, descending and settling, was being warmed adiabatically. When, however, an attempt is made to apply numerical data, cases arise where the change of temperature at a given point in space appears to have taken place much more rapidly than can be provided for by the most favourable time scale of the assumed operating causes. But in particular it is difficult to see why these causes should lead rapidly to the formation of comparatively sharp discontinuities of temperature of the order of 10° F., and also how they can lead to other than a very unstable vertical distribution of temperature. It seems much simpler, being provided with air of about the appropriate temperatures to northward and southward respectively, to explain the formation of anticyclones and their temperature distribution by means of the horizontal motion and interaction of these "polar" and "equatorial" currents.

A. H. R. GOLDIE.

Wimbledon, S.W.19, March 8.

The Phantom Island of Mentone.

On a fine dark night, looking towards the point of Mentone from the sea-front about the middle of the West Bay, the appearance is presented of a dark island rising out of the sea in the gap which separates the lights of Mentone from those of Bordighera, some ten miles distant. This "phantom island" appears to be about 200 feet high, and from its darkness one would imagine it to be thickly covered with vegetation, its sides rising steeply out of the water. It is directly opposite, and quite near the sea-front of Mentone, from which it is separated by a very narrow channel of water. It appears, in fact, to be quite close to Mentone.

The explanation of this curious optical illusion is comparatively simple. The lights of Mentone and those of Bordighera present the appearance of being ranged round a curved bay, and they throw their reflections on the water, but they are separated by the East Bay, which is not seen, and by a dark, unilluminated portion of the coast. The corresponding part of the sea is devoid of reflections, and the impression is produced of a dark obstacle breaking the continuity of the line of lights and of their reflections in the water. This effect has been seen by independent observers on several occasions.

G. H. BRYAN.

University College of North Wales,
March 6.

Ball Hardness and Scleroscope Hardness.

In the ball hardness test Meyer found that $L = ad^n$. By combining this relation with Brinell's formula $H = L/A$, it can be shown that the hardness number when the ball is immersed up to its diameter is $\frac{2a}{\pi}D^{n-2}$. This value has been called the "ultimate hardness" (H_u), and is independent of the initial condition of the metal with regard to cold work.

Several attempts have been made to obtain a relation between standard Brinell and scleroscope numbers. The results have been more or less unsatisfactory. If, however, values of H_u be plotted against the scleroscope numbers of metals in the annealed condition, the points lie on a smooth curve which is independent of the ball diameter. The following results have been obtained by the writer using balls of 1 mm. and 10 mm. diameter:

Sample.	a.	n.	H_u.	Scleroscope No.	Ball diam.
Tin	5·53	2·185	5·4	3·5	10 mm.
Zinc	24	2·21	25	11	
Steel A	74	2·288	91	27	
„ W	185	2·292	231	51	
„ 4	262	2·292	327	64	
„ 3	342	2·293	428	73	
Armco	94	2·164	60	21	1 mm.
Steel 2N	112	2·185	71	23	
„ A	150	2·247	96	27	
„ S90	264	2·298	168	41	
Manganese Steel	453	2·303	288	50	

These results are plotted in the diagram below (Fig. 1).

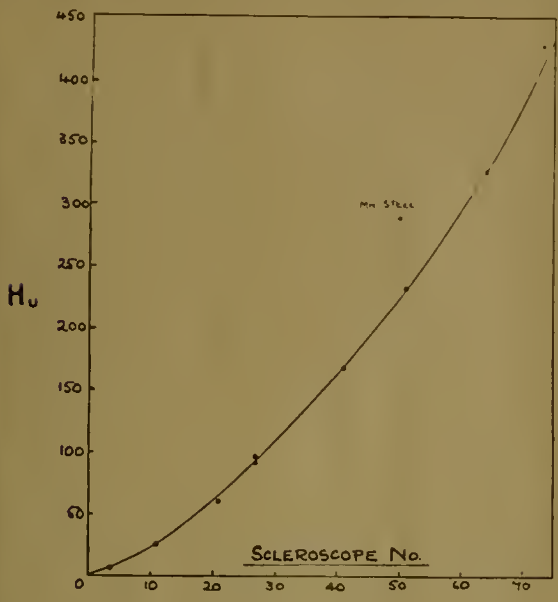

Fig. 1.

The relation between H_u and scleroscope number is quite good. The equation for the curve is:

$$H_u = 0{\cdot}79S^{1{\cdot}44}.$$

It is of interest that the ultimate hardness of manganese steel is higher than the scleroscope figure indicates.

If, as is believed, the value of H_u is independent of the ball diameter (D), then

$$kH_u = a_1 . D_1^{n_1-2} = a_2 . D_2^{n_2-2}.$$

k varies for different metals. Also, since with the 10 mm. ball

$$H_u = \frac{2a}{\pi} \times 10^{n-2},$$

then

$$0{\cdot}79S^{1{\cdot}44} = \frac{2a}{\pi} \times 10^{n-2},$$

$$S^{1{\cdot}44} = 0{\cdot}806a \times 10^{n-2}.$$

Hugh O'Neill.

The Victoria University of Manchester.
March 5.

Metallic Crystals and Polarised Light.

During a research, not yet completed, on the optical properties of crystals, certain observations made in the case of metals appear to justify publication, from their importance in metallurgy.

If an etched metal specimen is examined under the microscope with the usual mode of illumination, but with plane-polarised light, and the reflected light is viewed through a "crossed" analyser, the different crystals in the field of view are sharply distinguished by differences of brightness. Rotation of the stage causes the brightest to grow dark and the darkest to light up, each crystal passing through four maxima and four minima in a complete revolution. The portions thus marked off often form parts of a crystal which appears of uniform structure under ordinary illumination; some structural difference which is indistinguishable, or with difficulty distinguishable without polarised light, produces marked differences with the crossed Nicol arrangement, which thus promises to be an effective new weapon in the metallurgist's armoury.

Curiously enough, these phenomena were observed quite independently by Miss Olwen Jones, who is engaged on the above-mentioned research in this laboratory, and by my colleague, Mr. C. Handford, of the Department of Metallurgy, who was working on a quite different problem. It was only on consulting him on the metallurgical aspects of the matter that I learned that he had noticed the effects a few days before. Her work suggests to Miss Jones that the cause may very possibly be a fine striated or laminated structure of the crystals, producing a sort of serration of their surfaces, the direction of the striation differing from crystal to crystal. When the vertical plane containing the serrations is parallel or perpendicular to the plane of polarisation in the incident beam the reflected light is plane-polarised, and is therefore extinguished by the analyser; when the angle between those planes is 45° or 135° the ellipticity, and therefore the brightness, is maximum.

Further investigations are being made both to test this theory and to develop the metallographic technique of the method. J. H. Shaxby.

Viriamu Jones Physical Laboratory,
University College, Cardiff, March 12.

Easy Method of observing the Stark Effect.

In the course of our investigations on the pole effect of the iron arc, we used a special device to keep the arc steady in the vertical position, and photographed the spectrum by means of a large quartz prism on a Littrow mounting. The lines originating in the electrode, extending from the visible part of the spectrum down to the ultra-violet, showed distinct separation, which was identical with the Stark effect observed with vacuum tubes. The separated lines show polarisations parallel and perpendicular to the field, which at the maximum amounts to about 20,000 volts per cm., and is confined to a very thin layer at the electrode, indicating a steep gradient. We found it convenient to work with a 500 volts arc, although the same phenomenon can be observed with a 100 volts arc. The effect is observed at the lower electrode, whether this be anode or cathode. Other metals can be used instead of iron.

The observation of the Stark effect is thus rendered extremely easy, as the only process involved is the production of a steady arc and the use of a spectroscope sufficiently powerful to resolve the lines into components.

H. Nagaoka.
Y. Sugiura.

Institute of Physical and Chemical Research,
Hongo, Tokyo, February 13.

Volcanic Dust and Climatic Change.

On page 20 of his very interesting book, "The Evolution of Climate," Mr. C. E. P. Brooks says that I have "attributed glaciation to the presence of great quantities of volcanic dust in the atmosphere." This is too generous. I only insist that volcanic dust is one of the factors that control climate, and that at times it may (not must) have been an important factor, especially when mountains were high and continents extensive.

W. J. Humphreys.

U.S. Department of Agriculture,
Weather Bureau, Washington,
February 17.

The Character and Cause of Earthquakes.[1]

By R. D. OLDHAM, F.R.S.

THE character of earthquakes, that is, of the disturbance which can be felt and causes damage, has long been established as a form of elastic wave motion, originated by some sudden disturbance in the substance of the earth. In some cases, such as the Japanese earthquake of 1891 or the Californian of 1906, the earthquake was accompanied by visible fractures and displacements of the solid rock, and where these have been observed it has also been noticed that the violence of the disturbance reached its maximum close by, and became less as the distance from the fracture increased. From this it is evident that, in such cases at least, the earthquake originated from the jar caused by sudden rupture of the rocks, and the fault, or fracture, may be regarded as the cause of the disturbance to which the earthquake was due. In many other cases, where no actual faulting or fracture is visible at the surface, and especially in earthquakes of moderate intensity and extent, a study of the observations makes it very probable that the immediate cause of the disturbance was a fresh movement along an old fault, or the formation of a new one, and so may be found in many text-books the statement, put forward and elaborated, that faults are the cause of those earthquakes classed as tectonic. Thus it might seem that the cause of earthquakes had been explained, but this is only the beginning of the story, for we need to know what causes the fracture which gives rise to the earthquake.

In pursuing this object, reference may be made to an earthquake which occurred more than a hundred years ago, at a time when the observation of earthquakes was in its infancy, and when little information of present value could be expected, had it not been for certain peculiarities in the country affected, and in the effect of the earthquake. Just beyond the north-western angle of the Indian Peninsula lies one of the most extraordinary regions of the world, known as the Runn of Cutch; more than 200 miles in length, and some 30 in width, it is a level barren plain, so flat and so near the sea-level that when the waters of the sea are heaped up, by the south-west monsoon, and the streams from the surrounding country come down in floods, the greater part of the surface is covered with a sheet of water, varying from a few inches to five or six feet in depth.

The whole of this region, however, has not always been so barren as at present, for, up to the seventeen hundreds, a large river, fed by the waters of the Punjab, and by overflow from the Indus, flowed down through Eastern Sind, across the Runn to the Kori creek, and on the banks of this river were fertile and populated tracts; also on this river was situated a frontier fort of the Government of Cutch, where customs duties were collected. Then, in the eighteenth century, through changes in the river courses far inland, the supply of water in this river began to fail, and a series of bunds, or what we would now call barrages, was built to hold up the water and divert it for irrigation. Towards the end of the century, the whole of the water supply was intercepted, and the region below relapsed into a state of desolation; but the fort of Sindri was still maintained, with a small garrison and a few officials to collect the dues, and so things continued until June 16, 1819, when the classic earthquake of Cutch occurred.

The fort of Sindri was not only ruined, but the ground on which it lay was also lowered in level, water flowed in from the sea, and the small garrison of Sindri saved themselves from drowning by taking refuge in the main tower, whence they were rescued by boat the next day. Nor was this subsidence the only change noticed, for, about four miles to the north, where before had been only a dead level plain, the survivors observed a long low mound, stretching east and west with a height of about 20 feet, along the northern edge of the flooded area. This mound, so like an artificial embankment, was immediately named the "Allah Bund" or "God's Barrage," on the same principle which named the bunds or barrages higher up the stream after the names of their makers.

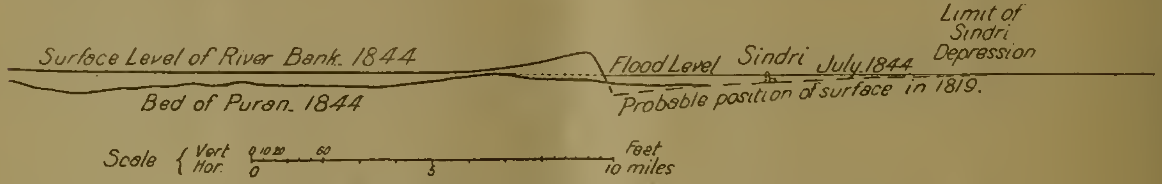

FIG. 1.—Section across the Allah Bund and Sindri depression of June 16, 1819.

Ten years later, the ruins of the fort were seen still standing out of a waste of waters, and twenty-five years later, in 1844, a careful survey was made and levels taken, and this survey revealed a remarkable condition of things (Fig. 1). From the north the surface of the delta sloped southwards, at about eight to ten inches in the mile, to within six miles from the crest of the Allah Bund, when a reverse slope was met, and the surface gradually rose to nearly 20 feet above the level of the continuation of the southerly slope, or the level at which it presumably stood before the earthquake. Thence there was a steep slope downwards, to the water of the Sindri lake. On the south the original reports mention a depth of twelve feet of water close to the shore, immediately after the earthquake, and, as the original surface level must have been a few feet above that of the sea, we have a depression of some fifteen feet, which gradually died out in a distance of some six miles to the southward. From these facts it is clear that there was no appreciable change of level at a distance of about six miles on either side

[1] Condensation of a course of two lectures delivered at the Royal Institution on January 30, February 6.

of the line of the Allah Bund, but that along that line the ground on the north was upraised by some twenty feet and on the south depressed by some fifteen at the time of the earthquake.

The next earthquake to be considered is one which has been investigated with great care and in great detail; it is the Californian earthquake of April 18, 1906. In this there was a visible fracture, following what is known as the San Andreas fault, along which the shock attained its maximum intensity. This fracture was crossed at various points by roads and fences, and after the earthquake it was noticed that, where these crossed the line of fracture, they were no longer continuous, but the ends were shifted laterally by distances which varied at different places, but frequently amounted to twenty feet. This was not all, for the displacement was of a very curious nature, revealed by surveys of the displaced fences, and by a repetition of the original trigonometrical survey of the region. These showed that for a distance of some miles back from the fault line the stations had been displaced, those nearest to the line by the greatest amount, which lessened as the distance increased and, at about five miles or so to the east, became very small. Moreover, it was found that the movement on the eastern side of the fault had been to the southwards, and on the western towards the north.

Here we have a result very like that in Cutch; in both cases there was a well-defined line along which permanent change of position of the ground took place, simultaneously, in opposite directions on either side of the line of separation, and in both cases the displacement decreased in amount with increasing distance, till it ceased to be measurable at a distance of about half-a-dozen miles. The only difference was that in California the displacements were horizontal, with little or no change of level, while in Cutch they were vertical, whether accompanied or not by horizontal shifting cannot be known.

Paradoxical though it may seem, this movement on opposite sides of the fracture in opposite directions is quite in accord with known physical principles. If any block of material is compressed or stretched in one way, while free to expand or contract in a transverse direction, or if it is twisted by two opposite sides being forced in opposite directions, a complicated system of strain is set up, and if the strain is more than the material will bear, disruption will take place, on opposite sides of which the material will move in opposite directions.

Models to illustrate this principle have been constructed by others and myself, and from these considerations there has arisen what is known as the elastic rebound theory of earthquake origin, and as generally expressed this takes the form of a very slow growth of strain and a sudden release by fracture. The former, however, is by no means necessary, and the same result, as regards displacements of the ground, would be attained if the strain was rapidly, even suddenly, produced. There are, in fact, reasons for supposing that the growth of strain is not slow but rapid, yet the fracture and elastic rebound theory might be accepted as sufficient, if earthquakes could always be attributed to a single fracture, or to a close-set group of fractures; but in the case of great earthquakes, and sometimes of minor earthquakes also, the interpretation is put out of court by a study of the distribution of the intensity of the disturbance.

In illustration I may take first the great Indian earthquake of June 12, 1897, in which the central region of greatest intensity covered an area of about 140 miles long by 40 miles broad, over which there was a complicated series of faults, fractures, and distortion, which was certainly widely different from the comparatively simple origin generally assumed for earthquakes. This seemed at the time sufficient to account for all the facts, though there were some recorded as difficult to explain, and later examination seems to have established the conclusion that the origin of the earthquake cannot be limited even to this extensive area. In this earthquake only two of the isoseists could be plotted in detail, those of eight degrees and of two, or the extreme limit at which the shock could be felt; both exhibit considerable irregularities of outline, the most conspicuous of which is a pronounced projection to the westwards, and on the continuation of this line is a detached area, where the shock was again felt, after a gap where it was not felt. Col. Harböe has suggested, from a study of the recorded times, that there was an extension of the origin along this line, and though his plotting of the origin cannot be accepted in detail, I am convinced that, in the main, his conclusions are correct, for they very materially help to explain some peculiarities of the recorded observations, which remained inexplicable on the older and more generally used interpretation.

From this it appears that in earthquakes covering a large area we are not dealing with a simple disturbance, starting from an origin of restricted dimensions and propagated outwards, but with one of complex origin; and that in the outer regions of the seismic area the disturbance may be compounded of wave motion propagated from a more or less distant origin, where the initial severity was great, and of that coming from a nearer origin, of a lesser degree of severity, so that, instead of a fracture of at most a few tens of miles in length, we have to deal with a cobweb-like system of fractures, or something analogous, which may run to hundreds of miles.

The general drift of the argument I wish to set forth is probably best illustrated by the California earthquake of 1906. In this the greatest degree of violence was found along the line of the San Andreas fault, but the plotting of the isoseists shows that there was not only an independent centre in the San Joaquin valley, some forty miles to the eastwards, but also several independent centres of great intensity at lesser distances from the San Andreas fault. Moreover, the displacements recorded by trigonometrical survey make it probable that other similar independent centres would be found to the west, if the waters of the ocean had not made observation impossible. The records, therefore, indicate a set of separate centres of disturbance, scattered over a region of about three hundred miles in length by very possibly one hundred miles in width, and these separate centres, though independent as regards the surface shock, were all evidently connected with some common cause. Had they been the result of breakage under a slowly growing strain it is difficult to understand how so complicated, scattered, and extensive a series of fractures could have originated simultaneously, but it is, to say the least, much less difficult to understand if the development of strain over the whole of the central area had been sudden, or at any rate rapid.

Then there is another point to be noticed, that in the central region the successive isoseists lie close together, while in the outer fringe they lie far apart; thus the distance separating the isoseists of ten and seven degrees, covering a range of three degrees of intensity, varies from 6 to 20 miles on either side of the San Andreas fault, while in the outer regions a similar range of three degrees covers from 120 to 250 miles. The close-set isoseists of the central region indicate a shallow origin, and such is proved by the San Andreas rifts, where the origin reached the surface of the ground; the widely set outer isoseists similarly indicate a deep-lying origin: and so we reach the conclusion that the earthquake origin was of a twofold nature, the great violence in the central region being due to fractures and displacements close to, or at a comparatively shallow depth below, the surface, and that these fractures were the secondary result of a more deep-seated disturbance or bathyseism.

Having reached this conclusion there remain two questions of importance, what is the depth, and what is the nature of this bathyseism? As to the depth, the study of a remarkable, though only feeble, earthquake which affected northern Italy on August 7, 1895, has led me to conclude that the ultimate origin lay at 100 to 150 miles below the surface; but the best indications are to be had from the long-distance records of disturbances, which need not necessarily have been great earthquakes, in the ordinary sense of the words.

From these Dr. L. Pilgrim, in 1913, deduced the conclusion that the origin of the disturbance, in the case of the Californian earthquake, lay at a depth of about 100 miles, and, more recently, a similar method has been developed in this country by Prof. H. H. Turner, who has shown that the long-distance records indicate depths of origin ranging from fifty to three hundred miles below the surface of the earth. Now it seems fairly well established that earthquakes of quite shallow origin do not give rise to distant records, even when very violent in the place where they are felt, and it is probable that the disturbance recorded by these distant seismographs is not the superficial destructive earthquake, but the bathyseism.

Next comes the question of the nature of the bathyseism. That it must be in some way accompanied by a change in bulk of the material underlying the central area of the earthquake, seems clear, in some cases at least. Fracture such as is sufficient to explain most of the features of the surface shock seems out of the question, for the depths place it in the region of what it is nowadays the fashion to call the asthenosphere, that is, a part of the earth which is weak and plastic against stresses of long duration; but as regards change of bulk, recent researches have indicated one very likely mode in which it might be brought about. It is known that the foundation rocks of the outer crust are everywhere composed of an aggregate of crystalline minerals, the detailed study of which shows that the material must once have been in a condition analogous to that of fusion, from which it has solidified by cooling to its present condition. Further, it has been shown that the same original magma may crystallise out as quite different mineral aggregates, differing in density, and therefore in volume, by anything up to 20 per cent. The exact conditions which determine the passage from one form of chemical grouping to another are not known in detail, but it is probable that in each case there is some critical limit of temperature and pressure which determines it. If there were, in the interior of the earth, a mass of material near this critical limit, a small change of pressure or temperature might bring about a change of chemical combination, and with it a greater or lesser change of bulk, which, transmitted to the upper layers of the earth's crust, would give rise to displacements and distortion. Such changes might be unaccompanied by earthquakes, if they were slow and gradual, or, if rapid or sudden, might give rise to fractures in the surface rocks, of greater or lesser magnitude, and covering a larger or smaller area, according to the bulk of the deep-seated material undergoing a change of volume.

Without insisting on this as the nature of the bathyseism, and it is possible that other causes as yet unsuspected may also be at work, it is evident that we have an explanation which would suffice in the case of the larger, and of many of the smaller earthquakes. Yet there are some causes, perhaps no inconsiderable fraction of the total, in which the whole process leading up to the earthquake seems to lie quite close to the surface. To these, always small in extent, though sometimes of considerable severity, the consideration which I have outlined cannot at present be applied; in part they must be due to quite different causes, the consideration of which is not without interest, but this interest only arises after more extended and technical study than could be presented, even in outline.

Hydrogen Ion Concentration.

By Prof. A. V. HILL, F.R.S.

CERTAIN solutions are capable of conducting electricity, although their separate pure components are themselves incapable, or capable only to a slight degree, of so doing. This conductivity is attributed to the "ionisation" of the dissolved body, that is, to the splitting up of its molecule into two or more parts, some carrying a positive and others a negative charge, the resulting "ions" being capable of migration under an imposed electric field, and so giving to the solution the power of carrying a current. The electrically neutral molecule breaks up into (*a*) a negatively charged part, containing an excess of electrons which lend it its negative charge, and (*b*) a positive portion with a deficit of electrons, this deficit resulting in an equal positive charge. These positive and negative ions attract one another, as do all positive and negative charges, and are separable only if their mutual attraction be small enough to be overcome by the inter- and intra-molecular dynamic forces (not yet properly understood) tending to their separation.

The attraction between two charges is far greater if they be separated by some media than by others, to a degree inversely proportional to the so-called specific inductive capacity of the medium. Water has one of the highest specific inductive capacities of all known substances, so that in it the attraction between two ions is relatively small: hence in water the ions may separate more effectively than in other solutions, and watery solutions are found to show the phenomena of electrolytic dissociation to an exceptional degree. Now water is a solvent of unique importance, partly because of its common occurrence, partly because it dissolves so many other bodies, and especially because, without exception, all biological phenomena occur in media which are essentially solutions or suspensions in water. Hence the study of the electrolytic dissociation of bodies dissolved in water is of quite peculiar interest, especially in physiology.

Now water itself is capable of electrolytic dissociation, though only to a small degree. In pure water at 22° C., eighteen parts in ten thousand million, that is, one ten-millionth part of one gram molecule per litre, is broken up into hydrogen ($H^{\cdot}$) and hydroxyl (OH') ions, the $^{\cdot}$ denoting the positive and the $'$ the negative charge. Such a very small degree of dissociation is of little importance in pure water: its insignificance is presumably due to the smallness of what we have called—to cover our ignorance—the dynamic forces tending to separate H_2O into $H^{\cdot}$ and OH'. In solutions, however, especially in solutions of acids and alkalies (that is, of bodies capable, by their own dissociation, of yielding one of the ions of water, $H^{\cdot}$ or OH'), even this small dissociation of water into its ions may become of preponderant importance.

It is obvious that the ions of the solvent itself, if present in appreciable amount, might be expected to play a special rôle in the behaviour of a solution: there is, however, a very real interest in the study of the hydrogen ion, in view of modern theories of the electrical constitution of matter. Atoms are supposed to possess a positive nucleus, with a charge equal to some multiple of the elementary negative charge on an electron, with layers of electrons circulating round the nucleus in stable orbits. The simplest atom of all is hydrogen, with a positive nucleus of unit elementary charge and a single negative electron revolving round it: remove this negative electron from a dissolved hydrogen atom, and we are left with a singly charged positive nucleus—next to the electron the simplest of all known natural bodies. In mobility, in combining power, in general dynamic effectiveness, this dissolved elementary unit might be expected to be, and actually proves to be, an agent of quite peculiar importance.

Expressing concentrations, in gram molecules (or ions) per litre, by means of brackets, it is found that at 22° C. in pure water,

$$[H^{\cdot}][OH'] = 10^{-14}.$$

This is the law of chemical mass action, which, in such a dilute solution as water is of its own ions, is accurately obeyed. Now in pure water there is no other agent capable of carrying electricity, and since the water itself cannot carry an appreciable resultant charge the positive and negative charges must balance one another, and therefore

$$[H^{\cdot}] = [OH'] = 10^{-7}.$$

If, however, we dissolve in the water another substance supplying one of the ions of water, for example, hydrochloric acid (HCl), which we may regard as being almost totally dissociated into its ions $H^{\cdot}$ and Cl', to a concentration (say) of one gram molecule per litre, then the equation above is entirely upset: the hydrogen ion concentration $[H^{\cdot}]$, or $c.H$ as we shall often call it, has now become unity instead of 10^{-7}, so that the hydroxyl ion concentration $[OH']$ is now only 10^{-14}. Even this, expressed in actual molecules, is an astonishingly large number: there are about 6×10^{23} molecules in a gram molecule, so that even in normal hydrochloric acid there are six million hydroxyl ions per cubic centimetre. Clearly, even a strong solution of acid contains an appreciable number of hydroxyl ions.

If, conversely, we dissolve caustic soda to make a "normal" solution, instead of hydrochloric acid, then $[OH']$ becomes unity and $[H^{\cdot}]$ becomes 10^{-14}. We may make up different strengths of acids or alkalies in which the hydrogen and hydroxyl ion concentrations

Acid.	$[H^{\cdot}]$.	$[OH']$.	Alkali.	$[H^{\cdot}]$.	$[OH']$.
N	1	10^{-14}	N	10^{-14}	1
N/10	10^{-1}	10^{-13}	N/10	10^{-13}	10^{-1}
N/100	10^{-2}	10^{-12}	N/100	10^{-12}	10^{-2}
N/1000	10^{-3}	10^{-11}	N/1000	10^{-11}	10^{-3}
N/10000	10^{-4}	10^{-10}	N/10000	10^{-10}	10^{-4}

may be calculated as in the accompanying table. It is usual to consider only the hydrogen ion concentration: the hydroxyl ion concentration may always be calculated from it, by dividing the quantity k in the equation $[H^{\cdot}][OH'] = k$ by $[H^{\cdot}]$. At 22° C., $k = 10^{-14}$, but it varies slightly with temperature. Now $[H^{\cdot}]$, or $c.H$, may change enormously from one solution to another, say from 10^{-14} to 1, that is, one hundred million million times: hence it is impossible to represent the full possible range of variation of $c.H$ in a single diagram, and since it is often necessary in physical chemistry to show the relations of $c.H$ graphically, it has become customary to express the hydrogen ion concentration in terms of logarithms. The logarithm of 10^{-14} is -14, and of 1 is 0, so that log $c.H$ can be represented, over almost the entire possible range, by numbers lying between 0 and -14. To avoid, further, the use of negative numbers the negative sign is understood, and the symbol $p.H$ (or its variants P_H, P_h, etc.) is defined by the expression $p.H = -\log c.H$. In this way, at 22° C., if $p.H = 7$ the solution is neutral, if $p.H$ be less than 7 the solution is acid, if $p.H$ be greater than 7 the solution is alkaline; and a decrease of $p.H$ means an increase in hydrogen ion concentration.

This system of nomenclature has certain obvious advantages if used with discretion: not seldom, however, it lends itself to obscuring the fact that the real agent at work is the actual hydrogen ion concentration $c.H$; it is difficult enough even for the expert to picture a quantity in terms of its negative logarithm, and it leads to confusion and suspicion on the part of the inexpert and beginner. For most of the phenomena of biology, moreover, which occur within a narrow range of $c.H$, it is quite unnecessary: for example, in physiology, apart from a few cases of secretion, the important range of $c.H$ in the body is from 10^{-7} to 10^{-8}, and it is better when possible to deal with the hydrogen ion concentration in multiples (or decimals) of 10^{-7}, and to use the $p.H$ notation only when the total range considered is outside the limits of any reasonable diagram: occasions, in physiology, where this occurs will be comparatively rare.

The hydrogen ion concentration of a solution can be measured in a variety of ways: (*a*) by calculation from the laws of mass action, with a knowledge of the components of the solution and the proper constants; (*b*) by the use of a so-called hydrogen electrode: if a platinum wire, coated with platinum black and saturated with hydrogen gas, be dipped into a solution, it acts like a metallic electrode of pure hydrogen, and its electrode potential can be measured and made to give the *c*.H of the solution; (*c*) by the use of so-called "indicators," that is, dyes which change colour as the hydrogen ion concentration is altered, owing presumably to changes in their degree of electrolytic dissociation: the colour is used to measure the value of *c*.H. The study and measurement of the hydrogen ion concentration is becoming to-day almost a complete science in itself, and progress in physiology, and in some branches of colloid chemistry, still waits on further improvements in the accuracy and adaptability of its technique.

The importance of the hydrogen ion concentration in biology is bound up with the phenomena attending the dissociation of weak acids and of the so-called amphoteric electrolytes, and with the theory of "buffers." A weak acid, for example, carbonic acid H_2CO_3, is one which is only slightly dissociated into its ions: the reaction $H_2CO_3 \rightleftarrows H^{\cdot} + HCO'_3$ goes almost entirely $\leftarrow$: similarly with a weak base. The salt of a weak acid is a very effective regulator of the hydrogen ion concentration; it acts as a "buffer" to resist the effect of adding a strong acid. Let the salt of the weak acid be XY, dissociated into its ions $X^{\cdot}$ and Y'. Let us add to this a strong acid HZ, dissociated into $H^{\cdot}$ and Z': we might expect the *c*.H to be largely increased. In our solution now are all the ions $X^{\cdot}$, Y', $H^{\cdot}$, and Z': $H^{\cdot}$ and Y', however, cannot exist side by side in solution in appreciable amount, since (by hypothesis) the acid HY is a weak one, that is, the reaction $H^{\cdot} + Y' \rightleftarrows HY$ goes almost entirely $\rightarrow$. Hence the hydrogen ions are eliminated to form the undissociated weak acid HY, and we are left (i.) with the ions $X^{\cdot}$ and Z' of the salt XZ of the strong acid, and (ii.) with the undissociated weak acid HY.

The expected increases in *c*.H can, in this way, be reduced almost to an insignificant amount, and in physiology (where an exact constancy of *c*.H appears to be necessary for the maintenance of the normal physico-chemical structure and behaviour of the living cell) the presence of very effective "buffers" in every organ, tissue, and cell has been shown in recent years to be of ultimate importance. Phosphates, carbonates, and the salts of proteins, such as hæmoglobin, are the chemical agents by which this regulation is effected. In addition to these we have what we may call "living buffers," the cells of the respiratory centre and the kidney for example, which by their activity maintain, in an amazingly accurate manner, the constant *c*.H required in the "internal environment" of all the other cells of the body; that is, in the blood and tissue fluids which bathe them. In the body, the important buffers are those absorbing the effects of added acid, especially carbonic and lactic acids, which are produced with great rapidity and amount during muscular exercise. The salts of weak bases, however, are equally effective buffers, from the physico-chemical point of view, in their capacity of neutralising the effect of strong alkalies. Some bodies, moreover, the so-called "amphoteric electrolytes," of which amino acids and proteins are the most notable, are capable of functioning both as weak acids and as weak bases: hence their salts (for example, sodium "hæmoglobinate," or hæmoglobin chloride) may act, under suitable conditions, as buffers of either type.

The importance of the hydrogen ion concentration in physiology is almost certainly concerned—at least in part—with the electrical properties of the proteins which constitute the formed constituents of living cells. It may also be concerned with the processes of oxidation and reduction occurring in metabolism, but with these we will not deal further now. Proteins are complex compounds of amino acids, and each amino acid possesses the latent possibility of acting either as a weak base (in virtue of its $-NH_2$ group) or as a weak acid (by reason of its $-COOH$ group). Hence proteins are capable, at a suitable *c*.H, of forming salts at many and varied points in their enormous molecules. These salts are largely dissociated into their ions, so that the protein of the living cell may be regarded as a large electrified molecule, surrounded by a shell of attendant positive (or negative) ions.

The electrical phenomena accompanying any form of activity in a living tissue demonstrate the importance of this electrification of the fundamental chemical basis of protoplasm, and it is well known that the existence and properties of colloidal solutions are intimately dependent upon the electrical charges on the surfaces of the colloidal particles. Now the degree of dissociation of a weak acid HZ, into its ions $H^{\cdot}$ and Z', depends upon the hydrogen ion concentration: according to the laws of chemical mass action the ratio of the dissociated to the undissociated part is inversely proportional to *c*.H. Hence, if the protein be acting as a weak acid, the degree of electrification of the protein molecule will be decreased by an increase of *c*.H, and if the behaviour of a living cell depend upon the electrical characters of its protein constituents we should expect it to be largely modified by an appreciable change in *c*.H.

This actually occurs: the most violent and extensive physiological response is produced, both in single cells and in larger complex animals, by quite small changes in *c*.H, and all animals possess the power of reacting, in a sudden and vigorous manner, to any alteration in the *c*.H of the fluid immediately in contact with their cells, in such a sense that the change is diminished, or neutralised, and the physico-chemical characters of the protein molecules of their protoplasm are maintained in their normal state. We know, at present, very little about the molecular structure of living protoplasm: we cannot, however, be far wrong in supposing that the ionic and electrical phenomena displayed by the protein molecules which constitute it are among its most fundamental properties, and that these are modified, to a high degree, in accordance with purely physico-chemical laws, by the hydrogen ion concentration of the fluid in which it is suspended or dissolved.

Obituary.

Dr. J. G. Leathem.

THE death of Dr. John Gaston Leathem on March 19, at the age of nearly fifty-two years, removes a scholar who was prominent in the world of Cambridge mathematics. Coming from Queen's College, Belfast, in 1891, he made his mark in the triposes of 1894 and 1895. He held the Isaac Newton studentship for astronomy and physical optics during the period 1896–99, soon gaining also a fellowship at St. John's College. His interests were then mainly in electrodynamic theory; and the work of his studentship produced a memoir (Phil. Trans., 1897, pp. 89-127), which ought to be classical, in which the theory of the magneto-optic rotation of light and the cognate reflection effect were finally systematised and coordinated, under the test of laborious comparisons with the numerical experimental data.

In due course Dr. Leathem became mathematical lecturer at St. John's College, and afterwards university lecturer: and for a series of years he exerted a wide influence on the teaching. For the mathematical tripos he was an examiner on as many as six occasions, two of them (1912, 1913) after he had been withdrawn from all teaching except an annual advanced course on electrodynamics. For he had become senior bursar of his college in 1908, and henceforth he threw himself into its external affairs and general administration with assiduity and practical success.

In 1905 Dr. Leathem took up the editorship, in conjunction with Prof. E. T. Whittaker, of a series of Mathematical Tracts projected by a Cambridge group of lecturers, which, in numerous volumes, has become under their care an important survey, almost an encyclopædia, of domains of recent higher mathematics. To this undertaking he contributed the earliest volume of the series, and one on optical systems. His own later special investigations, exhibiting the geometrical trend that is associated with the Irish school, thus including applications of conformal transformations to physical problems, were published mainly by the London Mathematical Society and the Royal Irish Academy. A note in Roy. Soc. Proc. established an unexpected mode of interaction between a magnet, supposed to consist of revolving electron-systems, and a varying electric field, too small, however, to permit of experimental scrutiny.

During the War Dr. Leathem felt bound to volunteer for work in the Research Department at Woolwich Arsenal, then in need of mathematical help, handing over as much of his bursarial work as was possible to senior colleagues. About two years ago he had to submit to a sudden and very drastic surgical operation: in time he recovered, and though never strong again, he resumed his activities with all the previous zeal and judgment. But the mischief could only be delayed, not removed: and his loss will now be deeply felt not only in his own college but also throughout the university.

J. L.

Dr. E. A. Merck.

THE death took place at Darmstadt on February 25 of Privy Councillor Dr. E. A. Merck, senior partner of the chemical works of E. Merck. Dr. Merck was born at Darmstadt on July 30, 1855; he studied pharmacology and chemistry, and took his degree in Freiburg i. B. under Ad. Claus. He then took over the Engel-apotheke, which had been in the possession of the family of Merck since 1668, and became one of the managers of the chemical works of E. Merck.

The works, which were then on only a modest scale, were greatly enlarged through the energy and initiative of Dr. Merck and his cousin, Louis Merck, who was his partner, and developed into one of the greatest manufactories of preparations for medical purposes. To the production of drugs was added that of alkaloids, the preparation of synthetic remedies (for example, "veronal"), and various sera. In response to the demand of chemists for pure reagents, the production of chemically pure preparations and solutions for volumetric analysis was taken in hand, and the firm's products became famous throughout the world. The connexion between the industry of chemical preparations on one hand and the pharmaceutical chemists and physicians on the other was steadily maintained by the literary publications: "Mercks Jahresbericht," "Mercks Index," and "Mercks Reagenzienverzeichnis."

Dr. Merck took an important part in all these developments. At the same time he worked continually for the improvement of the training of pharmaceutical chemists and the social position of the whole chemical profession. For six successive years he was president of the Verein Deutscher Chemiker, and he represented German chemistry at many international gatherings. His strong historical interest led him to give particular attention to the work of Liebig, and he was one of the founders of the Liebig Museum at Giessen.

WE regret to announce the following deaths:

Prof. A. S. Dogiel, professor of histology in the University of Petrograd, whose investigations on the histology of the peripheral nervous system are well known.

Prof. A. S. Flint, emeritus astronomer of the Washburn Observatory, University of Wisconsin, on February 22, aged sixty-nine.

Prof. W. S. Haines, professor of chemistry, materia medica, and toxicology at Rush Medical College, and professor of toxicology in the University of Chicago, on January 27, aged seventy-two.

Sir Joseph M'Grath, a vice-president of the Royal Dublin Society, and registrar of the National University of Ireland since 1908, on March 15, aged sixty-four.

Mr. W. Pearson, for nearly fifty-eight years prosector to the Museum of the Royal College of Surgeons of England, on March 15, aged eighty-two.

Sir Thomas Roddick, formerly professor of surgery, McGill University, and the first Colonial president of the British Medical Association, at its Montreal meeting in 1897, on February 20, aged seventy-six.

Sir William Thorburn, emeritus professor of clinical surgery in the University of Manchester, on March 18, aged sixty-one.

Prof. J. Trowbridge, emeritus professor of physics at Harvard University, on February 18, aged seventy-nine.

Mr. E. W. Vredenburg, of the Geological Survey of India, on March 12.

Prof. N. E. Wedensky, professor of physiology in the University of Petrograd.

Current Topics and Events.

The Conjoint Board of Scientific Societies was dissolved by a resolution passed at a meeting of the Board held at the Royal Society on March 22. The Royal Society took the initiative in the formation of the Board in 1916; and when a few months ago the council decided that the society no longer desired to remain in this federation, whether under the original constitution, or the new one proposed, there was little hope for the continued vitality of a body so sharply truncated. The chief scientific and technical societies—about sixty in all—in the British Isles were represented on the Board, and the special committees appointed from time to time have produced a number of notable reports. Among such committees may be mentioned those on the water power of the British Empire, glue and other adhesives, national instruction in technical optics, timber for aeroplane construction, and the application of science to agriculture. A couple of years ago the Board appointed a committee to arrange for the publication of a world-list of scientific serials, with indications of libraries in the chief centres of Great Britain where such periodicals could be consulted. It is gratifying to know that the interests of the Board in the list, towards the publication of which the Carnegie United Kingdom Trust made a grant of 1000*l.*, have been vested in three trustees, so that notwithstanding the dissolution of the Board the issue of the list is assured. For this provision thanks are due largely to Dr. P. Chalmers Mitchell. In its early years the Board owed much to Sir Joseph Thomson, who, as president of the Royal Society, was president also of it. Sir Arthur Schuster and Sir Herbert Jackson were associated with the Board throughout its existence, and did invaluable work for it, while the devoted service rendered by the Secretary, Prof. W. W. Watts, created a sense of indebtedness which can never be adequately expressed. It is impossible not to regret that a federation of such early promise should have had so short a life.

Sir Frederick Mott, pathologist to the mental hospitals of the London County Council for twenty-seven years, and director of the Council's pathological laboratory, is retiring from the service at the end of this month. By his own researches and by stimulating and encouraging the spirit of investigation in others, he has brilliantly discharged the difficult task of establishing the tradition that it is the business of the authority having control over asylums for the insane, not only to see to the security and comfort of the inmates, but also to secure that progressive work on the nature and causes of mental diseases shall be directed towards their prevention and cure. His demonstration that general paralysis of the insane is in fact a late manifestation of syphilis in the nervous system is perhaps the most conspicuous piece of his personal work among patients and in the laboratory, and it has entirely altered our conception of the disease. The *Archives of Neurology* and other journals show the quantity of good work which came from the laboratory at Claybury—the more remarkable when we remember that Sir Frederick was also a busy general physician attached to Charing Cross Hospital. Two of the plans in which he was much interested have now matured in the moving of the central laboratory to a more accessible site in London, and in the establishment of the Maudsley Hospital at Denmark Hill for the study of the early stages of mental derangement. The solid foundation which he has laid should do much to secure success for the new arrangements.

Among the important centenaries of scientific interest this year is that of the birth of Sir William Siemens, who was born in Lenthe, Hanover, on April 4, 1823, and died in this country on November 19, 1883. Siemens took up his residence in England in 1844, and from 1859 was a naturalised Englishman. It would be difficult to measure the value of his services to our industries, for he was one of the foremost electrical engineers of his day, while as a metallurgist his name is connected with the introduction of the regenerative furnace and the manufacture of open-hearth steel. His scientific knowledge was no less noteworthy than his inventive ingenuity, while above all he was a man of affairs. The first president of the Society of Telegraph Engineers, he also served as president of the Mechanical Engineers and of the Iron and Steel Institute. It was in his address to the latter body that he threw out the pregnant suggestion of utilising some of the power of the Niagara Falls and transmitting it long distances by electric conductors. In much of his work he was associated with his brothers Werner, Carl, and Friedrich. In the issue of Nature for November 29, 1883, Lord Kelvin gave an account of Siemens's scientific career and work as a contribution to our series of Scientific Worthies.

On April 7 occurs the centenary of the death of the French physicist Jacques Alexandré Cesar Charles, the pioneer of scientific ballooning. Born in 1746, Charles began life as a clerk in the Ministry of Finance. He devoted his leisure to scientific pursuits and he became known as a lecturer and experimenter. In 1783, a few months after the brothers Montgolfier had made their first experiments with the hot-air balloon, Charles conceived the idea of filling a balloon with hydrogen. His first important demonstration was made in December 1, 1783, when Charles and his companion, Francis Robert, rose from the gardens of the Tuileries to a height of 9000 feet. Charles made his hydrogen by the action of iron on sulphuric acid. To him is due the invention of the valve, the car, the use of ballast, and the employment of rubber for rendering the silken envelope gas-tight. He was also the first to use the barometer in a balloon. Very great interest was excited by the work of Montgolfier and Charles, and Lavoisier was instructed by the Paris Academy of Sciences to draw up a report as to the value of the discovery. Charles was admitted to the Academy in 1785, received a pension from Louis XVI., and, after the Revolution, occupied a post at the Conservatoire des Arts et Métiers. He is buried in the Père-Lachaise cemetery.

Thanks to the generosity of the Spanish Government the Science Museum, South Kensington, now possesses a model of the flagship of Columbus, the *Santa Maria*, in which, accompanied by the *Pinta* and *Nina*, he made his famous voyage of discovery in 1492. The model is a copy of one in the Naval Museum, Madrid, and has been made under the supervision of the director, Capt. Don Antonio de la Reyna y Pidal. From time to time many inquiries have been made regarding the details of the *Santa Maria*, and for the Chicago Exhibition of 1893 a replica was constructed and sailed across the Atlantic by a Spanish crew under Capt. Concas, the course followed being that travelled by Columbus. The *Pinta* and *Nina* were small vessels of about 40 or 50 tons, but the *Santa Maria* had a displacement of 233 tons. She was 95 feet long over all, carried a complement of 52 men, and mounted eight guns for firing stone shot. Another of the existing models of the *Santa Maria* is that made by Capt. Terry, who searched Southern Europe for information; this model is illustrated in Chatterton's well-known "Sailing Ships and their Story."

Mr. Stanley Baldwin, Chancellor of the Exchequer, announced in the House of Commons on March 22 that he had decided to withdraw the proposal to charge fees for admission to the British Museum, Bloomsbury, and the Natural History Museum. The announcement followed a statement by Major Boyd-Carpenter, Parliamentary Secretary to the Ministry of Labour, that the cost of equipping the British Museum and the Natural History Museum with turnstiles for the collection of admission fees had been estimated at £500, and that possibly one extra attendant would be required.

A conventional distinction is often drawn between science and art, but in their finest developments they have much in common. In an address before the Circle of Scientific, Technical, and Trade Journalists on March 20, Prof. Beresford Pite defined the artist as one who found his pleasure in his work—a definition that surely applies equally well to the researcher in pure science. He also pointed out that the full development of architecture requires the stimulus of contact with other countries. The Elizabethan period was one of poverty in architectural effort, though literature flourished, a condition attributed to the isolation of this country from the Continent, owing to religious differences. This again applies to science, for the crippling effect of lack of intercourse with men of science in other countries is well recognised. Perhaps a third point of similarity might be found in his claim that the architect, like the man of science, does much work without prospect of reward. He is not paid for what he "rubs out," neither is the experimenter proportionately rewarded for the many fruitless experiments that usually precede a genuine discovery. In the course of the discussion the Press, the influence of which in directing public attention to the claims of science has already been invited at previous meetings, was given an opportunity of hearing a masterly lecture on the ideals of architecture.

The annual meeting of the National Institute of Industrial Psychology was held on March 20 at the rooms of the Royal Society. Mr. H. J. Welch, chairman of the Institute, presided. Lord Balfour was the principal speaker, and he pointed out how mistaken is the idea that science has nothing to do with practical life. As a nation we are too apt to think that science exists for men of science, and that it can have no interest for practical men. He wished to bring together men of science, capitalists, leaders of labour—all the forces of society—in order to further the work of uniting science and practice. By the application of physiology and psychology Lord Balfour expressed the hope that the labours of the wage-earners may be made easier and smoother, so that work, instead of being a kind of torture, may become a pleasure. He quoted Francis Bacon to the effect that the object of science is the relief of man's estate. The next speaker, Sir Charles Sherrington, president of the Royal Society, described the changes which have taken place during his lifetime in the position of psychology. The early pioneers in experimental psychology occupied themselves with problems which seemed quite remote from any practical application; now, many of these early researches are recognised as of far-reaching practical importance. Sir Charles made a special plea for adequate support for, and sympathy with, that part of the work of the Institute which is known as vocational selection. Most boys have no chance whatever of getting into an occupation that suits them best; unguided, they drift into any trade. Both Sir Lynden Macassey and Mr. A. Pugh showed from different points of view that there is more waste in industry owing to indifferent management than to indifferent workmanship. Industrial managers are more equipped, as a rule, for controlling machines than for controlling men. Dr. C. Myers, director of the Institute, gave some details of the actual work of the Institute.

The Central Mining-Rand Mines premium of 25*l.* has been awarded by the South African Institution of Engineers to Mr. W. J. Horne, organiser of technical education, Transvaal, for his paper on "Technical Education for Trades," read at Johannesburg.

At the ordinary scientific meeting of the Chemical Society held on March 1, Prof. Bohuslav Brauner, Prof. Ernst Cohen, Prof. Gilbert N. Lewis, Prof. Charles Moureu, Prof. Amé Pictet, and Prof. Theodor Svedberg were elected honorary fellows.

The King and Queen have consented to lay the foundation-stones of the new buildings for medical research at University College Hospital, London. These buildings, it will be remembered, have been made possible by a munificent gift of 1,250,000*l.* from the Rockefeller Foundation, announced some three years ago. It is probable that the ceremony will take place towards the end of May.

THE annual general meeting of the Society of Chemical Industry will be held at Cambridge on June 21–23. Dr. E. F. Armstrong will deliver his presidential address on the first day of the meeting. On June 22, the Society's medal will be presented to Dr. C. C Carpenter, and later in the same day Dr. F. W. Aston will deliver an address on "Isotopes." During the early part of the same week, it will be remembered, the International Union of Pure and Applied Chemistry is also meeting at Cambridge.

AT the annual general meeting of the Chemical Society, held on March 22, Sir James Walker, the retiring president, delivered his presidential address entitled "Symbols and Formulæ." The following elections were afterwards declared: Prof. W. P. Wynne as president; Prof. J. F. Thorpe as treasurer; new vice-presidents, Dr. J. T. Hewitt, Prof. G. T. Morgan, Sir William J. Pope, Prof. J. M. Thomson, and Sir James Walker; new members of council, Dr. E. F. Armstrong, Prof. W. N. Haworth, Dr. C. K. Ingold, Dr. H. McCombie, Dr. G. W. Monier-Williams, and Dr. J. Reilly.

IN Great Britain the period of Summer Time will begin this year at 2 A.M., G.M.T., on Sunday, April 22, and will continue until 2 A.M., G.M.T., on Sunday, September 16. In Belgium, Summer Time begins after midnight on March 31. The Paris correspondent of the *Times* states that, in order to meet the opposition to Summer Time from representatives of agriculture in the Chamber of Deputies, the French Government has decided to substitute for it the time of Strasbourg, which is about thirty-five minutes in advance of Greenwich time.

WITH reference to the letter published in NATURE of February 17, p. 222, describing a remarkable mirage observed at Cape Wrath on December 5, 1922, a letter has been received from Mr. Albert Tarn of Thornton Heath, who describes a somewhat similar occurrence at Oban in August 1885. Mr. Tarn states that he was sleeping in a bedroom at the back of a house adjoining the Waverley Hotel, so that the room faced inland. During the course of the night he awoke, and on looking out of the window saw what appeared to be a view of Oban Bay with the moon shining on the water. The date is not given, and no observations are available to decide whether the circumstances resembled those at Cape Wrath.

THE report of the National Museum of Wales for 1921–22 announces the completion of the western section of the new building and of the western portion of the entrance-hall. A fumigating chamber has been installed to rid specimens of insects and other pests. Among the many interesting accessions we note a beaker of early Bronze Age type from Glamorganshire, which contained the remains of a child's skull showing symptoms of rickets, the earliest recorded instance of this disease in Great Britain or perhaps in the world. Several thousand specimens of fossil plants most carefully collected from the successive beds in the Coal Measures of Gilfach Coch and Clydach Vale by Mr. David Davies, and the basis of his recent paper before the Geological Society, have been presented by him and will be preserved in cabinets given for the purpose by local bodies interested in the coal industry.

THE Australian National Research Council has commenced the publication at Sydney of a quarterly journal under the editorship of Dr. A. B. Walkom, which is to give short abstracts of papers written by Australian scientific workers—even when they appear in periodicals not published in Australia. The price of the journal is 4s. per annum. The first four numbers of the journal have already appeared, and extend to 32 pages. The abstracts are arranged in sections according to the branches of science represented on the Research Council, and the 245 which constitute the first year's total are distributed among the sections as follows: agriculture 70, botany 31, chemistry 14, engineering 1, geography 1, geology 18, mathematics 1, mining and metallurgy 0, pathology 13, physics 1, physiology 4, veterinary science 3, zoology 88. Cross references are given so that an abstract of interest in a section other than that in which it appears can readily be found. The distribution of the abstracts among the sections is interesting as evidence of the extent to which science is being brought to bear on the special problems which a developing colony presents to its Government.

MR. J. REID MOIR is publishing through Mr. W. E. Harrison, the Ancient House, Ipswich, under the title of "The Great Flint Implements of Cromer, Norfolk," an account of his discoveries in 1921 of a large and remarkable series of flint implements and flakes, to which attention has already been directed in the columns of NATURE. The forthcoming volume will contain a number of illustrations by E. T. Lingwood.

WE have received from Messrs. Watson and Sons Parker Street, Kingsway, Bulletin 50.S., containing descriptions of some new X-ray accessories. A new mercury interrupter with a rotary rectifier designed for continuous work under heavy loads is illustrated, also an automatic time-switch for exposures ranging from one-sixteenth of a second to thirty seconds. The extensive use of X-rays for therapeutic purposes has led to great improvements in the design of suitable stands which serve the double purpose of holding the X-ray tube and allowing it to be manipulated at any angle. The new stand illustrated here has some good constructional features, and the tube itself is almost completely enclosed by protective material which has an absorption equivalent of 3 mm. of lead. This protective shield is provided with an arrangement which permits of forced air cooling during the working of the tube.

THE 1922 Year-Book of the Franklin Institute, Philadelphia, contains some interesting facts from the history of the Institute. It was organised in 1824 for "the discovery of physical and natural laws and their application to increase the well-being and comfort of mankind," and duly installed in its own house two years later. It is noteworthy that in 1831 a joint committee of the Institute and the American Philosophical Society began systematic meteorological observations in aid of agricultural and other interests, and eight years later the Pennsylvania legislature made a grant of 4000 dollars for the purchase of instruments at the discretion of the Institute; this is stated to be the earliest instance on record of the appropriation, in any country, of public funds for the collection of facts relating to the weather. The Institute awards medals, of which the best known is the Franklin medal, for distinguished work in advancing physical science or its applications; it was founded in 1914, and among its recipients have been Sir James Dewar and Sir J. J. Thomson. Other awards made are: the Elliott Cresson medal, for research and invention; the Howard N. Potts medal, for distinguished work in science or the arts and for papers presented to the Institute; the Edward Longstreth medal, for meritorious work in science or the arts; and the Boyden premium of 1000 dollars, to any resident of N. America who shall determine by experiment whether all rays of light and other physical rays are or are not transmitted with the same velocity; an award was made in 1907 for a solution dealing with the visible and ultra-violet parts of the spectrum.

Our Astronomical Column.

Meteors in April.—Meteors are seldom abundant in April, but there are a number of interesting showers visible, including the Lyrids, which are connected with the first comet of 1861. This display usually attains a maximum on April 21, and the conditions will be rather favourable this year, as the moon will be visible only as a crescent in the evening sky. The Lyrids exhibit a radiant which moves eastwards about 1 degree per day, and we require more evidence on this point. The shower, however, is of very short duration in its active stage, and meteors belonging to it are rarely seen two or three days before or after the date of maximum.

In April there are a large number of feeble showers which it is desirable to investigate further. These include positions near α Persei, β Ursæ Majoris, α Cygni, α Cephei, etc. In Hercules, Corona, Boötes, and Ophiuchus there are a few well-pronounced displays which apparently recur annually.

The Eclipse of September 1922 in Queensland.—Mr. J. C. Russell, of Brisbane, sends some notes on his observations of this eclipse made at Stanthorpe, a favourite summer resort, nearly 3000 feet above sea-level. The N.S.W. Branch of the B.A.A. were also stationed here. There was an extensive view over the plain to the west, and the moon's shadow was seen approaching, a little in front of the horizon line, and therefore about 10 miles distant, looking like a local rain squall. Shadow bands were observed at the same time. The central dark bands were 12 or 15 inches apart, about 4 inches wide, fringed with an equal width of half-tone on each side, and a bright strip between them. They passed at the rate of 10 per second. Their least distance from his eye was 8 feet. They were followed to a distance of 30 or 50 feet, where they appeared fainter but 3 or 5 times wider than when nearest. He ascribes them to compressional waves in the air caused by the cooling effect of the shadow cone, which was passing at a rate exceeding that of sound. Mr. Russell also makes the plausible suggestion that the shapes of the bands as seen are largely modified by the phenomenon of persistence of vision. He thinks the apparent enlargement at a distance was a (partly mental) effect due to this cause.

During totality the shadow covered most of the sky, but near the horizon to north and south there was a red glow, due to distant regions of the atmosphere beyond the shadow. (This effect was also seen in Norway in 1896.) The shadow was 120 miles wide, and the observer 9 miles north of the centre.

The corona was seen with direct vision to a distance of $\frac{3}{4}$ diameter from the limb, being very bright: with averted vision two faint extensions were seen, one to N.W., the other in the upper part, each 5 minutes wide and reaching to $1\frac{1}{2}$ diameters from the limb; they gave the corona the appearance of a wind-vane, a simile used on former occasions. Mr. Russell's description of the corona mentions three immense "spearheads" of white light, one to the zenith, the other two on the lower side, the left-hand one being the larger; these formed "as it were a great forked beard." A ruby spot, doubtless a prominence, was seen on the low left hand.

A few stars were seen during totality, but they were not specified. An account in B.A.A. Journ. (Jan.) by Dr. A. F. Turner states that six were seen, of which Venus, Mercury, Jupiter, and Spica were identified; two that were seen far to the south may have been α and β Centauri.

Problems of the Nebulæ.—The Rev. H. Macpherson contributes an article on the nebulæ to *Discovery* (March). The numerous and rapid changes of view that have taken place with regard to them illustrate the difficulty of knowing where to place them in schemes of stellar cosmogony. The "island universe" theory of the spirals was received back into general favour ten years ago, but Mr. van Maanen's detection of perceptible rotatory movements in several of them, in combination with the spectroscopic determination of radial velocities, enables hypothetical parallaxes to be estimated. These correspond to distances of a few thousand light years, so that they appear to be within the limits of our own universe. Dr. Jeans regards the luminous knots on the rims of these spirals as giant stars in process of formation at the rate of one every few centuries.

There is another difficulty not felt at the time when stellar types O, B, A were supposed to be the earliest in the spectral sequence, which the "Giant and Dwarf" theory renders puzzling: this is the frequent association of these types with planetary nebulæ in the case of O, and with bright diffused nebulæ in the cases of B, A (Orion and the Pleiades). It would seem that these nebulæ can scarcely be regarded as the parents of the stars that they surround, since, if such were the case, they would be much more in evidence round giant stars of type M. The conclusion appears to be that the natural condition of nebulosity is dark, but that it may become bright either by simple reflection, as appears to be the case with the nebulæ in the Pleiades, or by selective excitation, which causes some of its gases to glow. Prof. Russell compares this to the excitation that occurs in a comet when near perihelion.

Research Items.

Archæological Exploration at Zimbabwe.—A noteworthy contribution to the discussion of the origin and date of the Zimbabwe ruins appears in the recently issued vol. xx. of the Proceedings of the Rhodesian Scientific Association in the form of a communication from Mr. H. R. Douslin, lately Director of Public Works, on "Recent Explorations at Zimbabwe." Mr. Douslin has excavated the ruins on two occasions. In 1909 the trench made by Dr. Randall-MacIver in 1905 was carried down to solid rock by a pit under the wall of the Temple. The base of the foundations was reached at about 2 ft. and the rock at about 10 ft. below surface level. Only broken pottery, of a type common to all the ruins and similar to that made by natives to-day, was found. In 1915 excavations were carried out inside the wall of the Acropolis, which it is assumed was built before the Temple, and a large part of the red-earth filling was removed. The original entrance was discovered—a passage many feet below what is considered to be the original foundation of the wall on the western side. It ended against a dead wall of the internal red-earth filling. This filling, on which many of the internal walls are built, would therefore appear to be of more recent origin than the main outer wall. Solid rock was reached at about ten feet below present surface level, where the old dwellings were found. Their workmanship is superior to that of present-day natives and of a character unknown to them. The finds included two finely ornamented copper bands, an iron shackle, assegais, fragments of a soapstone bowl, and the usual Kaffir beads and pottery. No gold was found, and the author points out that the gold ornaments, etc., for which the greatest antiquity has been claimed, were found on or near the surface ten feet above the original occupation level.

Social Significance of U.S. Army Intelligence Tests.—Prof. P. E. Davidson discusses in the *Scientific Monthly* (February 1923) some of the generalisations which have been drawn from the now well-known American Army intelligence tests. These tests, originally applied in order to differentiate men for army posts, disclosed the unwelcome fact that large numbers of the population ranked very low in innate intelligence. Some writers have concluded from this that the traditional democratic ideal must be renounced, as only a gifted few are capable of ruling. The writer of the article believes, however, that three assumptions have to be made if such conclusions are sound: (i.) that the army draft was truly representative of the American population in general; (ii.) that the tests were really tests of native ability and not of educational advantages; (iii.) that the native intellect in question is so general as to condition social success of any significant kind. He gives reasons for disputing each of these assumptions, and shows that large numbers of the more intelligent members of the community were unrepresented, that the tests made heavy demands on language knowledge, and that many factors other than native ability help to determine a man's social position. While agreeing that the gifted minority should have every possible advantage, he disputes the belief that these alone should be trained, while large numbers are to be denied training because of an arbitrarily imputed stupidity. The article gives a salutary and timely check to the ardent enthusiasts who would impute to tests more than they can legitimately bear. It is frequently the social applications of scientific research that are unscientific.

Efficiency in Fine Linen Weaving.—A report on fine linen weaving has been prepared by Mr. H. C. Weston on behalf of the Industrial Fatigue Research Board (Report No. 20, "A Study of Efficiency in Fine Linen Weaving," Textile Series No. 5, H.M.S.O., 1922, 1*s*. 6*d*. net). The investigation was undertaken for the purpose of enabling a comparison to be made between the conditions of work and efficiency in linen-weaving sheds and in cotton-weaving sheds, the latter having previously been investigated. The output from each of forty looms was recorded, hourly readings of the wet- and dry-bulb temperatures were taken, and the amount of time noted during which artificial light was used. A detailed description of the nature of the weaving process is given and the general conditions of the sheds. Tables showing the hourly, diurnal, daily and weekly variations of efficiency and temperature are appended. The writer concludes that there is evidence to show that the economic limit of temperature for fine linen weaving is reached when the wet-bulb temperature exceeds 73° F. Up to this limit increase of temperature results in increase of productive efficiency, but beyond it efficiency falls owing to the discomfort and fatigue of the workers. He also shows that the use of artificial light reduces efficiency approximately by 11 per cent. of its normal daylight value. A similar result was reported in a previous investigation made by the Industrial Fatigue Research Board into silk-weaving. These results are not unworthy of consideration in discussions of daylight saving.

The Distribution of Megalithic Monuments in England and Wales.—In the Proceedings of the Manchester Literary and Philosophical Society (vol. lxv. No. 13) Mr. W. J. Perry supplies some further arguments in support of his theory that megalithic monuments were the work of a race of miners engaged in the search for precious metals and other valuables. This he holds to be established in the cases of Cornwall, Devonshire, Wales, Derbyshire, Northumberland, and Cumberland. The difficulty remains regarding those in Dorset, Wilts, and Oxford, including Stonehenge and Avebury. The explanation is that this latter series is situated on the Upper Chalk flint-bearing formation. "Flint implements," he remarks, "are found in all parts of the country, even in places far away from the source of the material. Sir John Evans mentions particularly Devon and Cornwall as regions where there is an abundance of flint implements and flakes, and these counties have no flint-bearing formations, though in some places there are some on the surfaces. These would not be nearly so good for the purpose as those from the chalk regions of Wilts and Dorset. We have thus the remarkable fact that flint implements are found all over the country, and that the builders of megaliths, including long barrows, have chosen out those very portions of the chalk country which produce flints."

Distribution of Organisms in Culture Media.—As a rule the accuracy of biometrical determinations must be ascertained empirically from a statistical study of the observations; in certain cases, as has been shown in the theory of hæmocytometer counts, the law of variation may be calculated, and the accuracy known with precision, provided the technique of the counting process is effectively perfect. A study of the extensive bacterial count data accumulated at Rothamsted by Cutler and Thornton, using Thornton's agar medium, indicated that the same law of variation, the Poisson series, was obeyed by the number of colonies counted on parallel plates. Statistical tests were devised which proved that, save for a small proportion of definite exceptions, the necessary perfection of technique was effectively realised (R. A. Fisher, H. G. Thornton, W. A. Mackenzie, *Annals of Applied Biology*, vol. ix. p. 325, 1923). In studying the exceptional cases it appeared that these fall into two classes, (1) an abnormally high variation which, when investigated experimentally, has been traced to certain bottom-spreading organisms isolated from soil from Leeds and from Rothamsted, and (2) an abnormally low variation ascribable to defective procedure in the preparation of the medium. Application of the same tests to other extensive series of bacterial counts showed that a similar approach to theoretical accuracy, though rare, had been obtained by Breed and Stocking in counts of *B. coli* in milk. It should be emphasised that all cases of departure from the theoretical law of distribution, which have been investigated, are associated with large systematic errors in the means; for this reason simple tests are presented by which such deviations from the theoretical accuracy of the method can be detected.

Primulas of Central Asia.—Mr. F. Kingdon Ward, who was referred to in Nature of February 17, p. 231, as returning to England after extensive travels in Central Asia, has been contributing some account of his previous (seventh) expedition in Asia in the *Gardeners' Chronicle* since May 1922. These articles not only describe very vividly the first discoveries of many new plants, to be of interest afterwards to the British growers of novelties, but also frequently raise interesting general questions from the point of view of a keen observer of plants; as, for example, the discussion in the issue of February 10 (p. 80), as to the association of meal—a granular waxy deposit developed on the cuticle—and fragrance in the Primulas, and the observation that the Primulas found growing on boggy habitats are generally without meal.

The Cuticle of Cotton.—A paper by R. G. Fargher and M. E. Probert, in the Journal of the Textile Institute, vol. 14, pp. T49-T65, February 1923, seems to represent a notable advance in our knowledge of the chemical composition of the plant cuticle. Material extracted from American cotton by benzol, heating with superheated steam, was available from some very large scale experiments. This method opens up the possibility of hydrolysis during extraction, but the large bulk of material made available by the scale of operations has provided very precise information as to certain constituents of the cotton wax, although doubt may remain as to the exact form in which they are present in the cuticle. A new alcohol, gossypyl alcohol, $C_{30}H_{62}O$, is identified and described, montanyl alcohol, $C_{28}H_{58}O$, present in smaller amount, is also described for the first time; small amounts of ceryl and carnaübyl alcohol were also found, and a mixture of phytosterols; little if any glycerol was present. Palmitic, stearic, and oleic acids were found in the free state, the sodium salts of montanic, cerotic, palmitic, and stearic acid were identified, as well as the salt of an acid, $C_{34}H_{68}O_2$, oleic acid and a lower isomeride of oleic acid were present as esters, but the proportion of unsaturated acids, either free or combined, was small. While this work, on one hand, will throw much light on the problem of scouring cotton, on the other, it gives much needed information as to the chemical constituents of the plant cuticle.

The Isoetaceæ.—Norma E. Pfeiffer has published a most valuable systematic study of this family in the Annals of the Missouri Botanical Garden (vol. 9, No. 2, April 1922). After a brief account of the morphology and ecology of the genus, which is incomplete as a bibliographical account of European work upon Isoetes, the species are grouped into sections, and keys are provided for the identification of species within the sections. Breaking away from former systematic studies, where habitat characters have largely been used for the establishment of main subdivisions, the present sections are based upon the megaspore surface, whether tuberculate, spiny, crested, or reticulate. Within the sections great use is made of the lobing of the corms and the amount of development of the velum; megaspore characters are again frequently used, and eight plates are provided with photographic illustration of megaspores of different species. The family is a remarkable one to the student of plant distribution. Of the 64 species described, most are very restricted in range, the only exceptions being *Isoetes Braunii*, Dur., in North America, and *I. lacustris* and *I. echinospora* in Europe. Some of the Mediterranean forms appear to the author to show close affinities, as though originating from a common stock; but, on the whole, present knowledge of the species and their distribution is too puzzling, and probably too incomplete, to encourage premature speculation as to centres of distribution and evolutionary tendencies. It is interesting to find one submerged species—*I. echinospora*—always without stomata while *I. Braunii* always possesses some.

Physiography of Porto Rico.—A detailed study of the physical geography of the West Indian island of Porto Rico by Mr. A. K. Lobeck is published by the New York Academy of Sciences (vol. i. pt. 4). It is the last section of a complete survey of the island undertaken by the Academy. The present part, which includes a large-scale map, is the outcome of field work in 1916–17. The physiographical history of Porto Rico appears to have begun with a complex mass of igneous rocks which were eventually reduced to a peneplain, except for two well-defined monadnock groups, now known as the Luquillo mountains and the Cordillera Central. No direct evidence on the horst nature of this ancient land mass was available. Uplift of the peneplain led to a new cycle of erosion, but only along the northern side of the island was a second peneplain produced. On the south the island was worn down less effectively, probably because of inadequate rainfall. Partial submergence then allowed the formation of coastal plains on both north and south sides which, after uplift, were considerably dissected. Mr. Lobeck traces these events and discusses also recent changes now in progress, illustrating his lucid paper by photographs and block diagrams. Some notes are added on the islands of Desecheo, Mona, Vieques, Culebra, and Muertos.

Pliocene Vertebrates from the Tertiaries of Arizona.—On the initiative of the United States Geological Survey and with the co-operation of the United States National Museum, Mr. J. W. Gidley went early in 1921 to collect fossil vertebrates in the San Pedro Valley, Arizona, with the view of establishing the age of the deposits there, which until then had been termed Pleistocene. A preliminary report has now been issued as Professional Paper 131-E of the United States Geological Survey. Unfortunately the material collected represents for the most part new species which cannot therefore be correlated with known faunas of other localities where the age of the beds has been established. With two or three species of true horse (Equus) are associated the remains of Hipparion, Pliohippus, some Proboscidia, Camelidæ, Cervidæ (including Merycodus), Carnivora, numerous Rodentia, and Glyptotherium, as well as reptilian and bird remains. The author, therefore, refers these beds to the Pliocene, and points out that the presence of a true llama, a glyptodont, and a rodent belonging to a genus now living only in South America, bears out the theory of the derivation of the South American fauna by migration from North America, and that such migration may have taken place about this epoch. Detailed descriptions, with figures, of the Rodentia and Leporidæ, all of which represent new species and total some twenty in number, form the major portion of the paper. The reptiles and birds are to be dealt with later by other writers.

THE HIMALAYAN MOUNTAIN SYSTEM IN SOUTH-EAST ASIA.—One of the objects of Prof. J. W. Gregory's recent journey to Yunnan was to study the geographical relationships of the Alps of Chinese Tibet. A sketch of his conclusions appears in the *Geographical Journal* for March. He contends that the structure of western Yunnan is best explained on the view that the line of Himalayan folding is not wholly bent in Assam into the Burmese arc which follows the Arakan mountains, the Andamans, and the Nicobars into Sumatra, Flores, and Timor. Two routes have been suggested as the eastern prolongation of the Himalayas, the Great Khingan mountains, and the Tsinling mountains. The former view is untenable owing to the essential difference in structure; the latter is a doubtful thesis since there are indications that the Taliang Shan of southern Szechwan, which would appear to be a link in this chain, are east and west folds of Hercynian age. The evidence is more in favour of the Himalayan line being continued in the Nan Shan mountains, which separate the Yangtze Kiang from the Si River, although information as to their geological structure is still meagre. According to Prof. Gregory's interpretation, the Burmese-Malay arcs of folding form a loop on this eastern prolongation of the Himalayan axis comparable with the Persian loop in western Asia and the Apennine loop in Europe. The eastern end of the Malay arc is generally represented as a reversed bend round the Banda Sea. Prof. Gregory agrees with Suess that this is not so, and holds that the Malay arc continues into the mountains of south-eastern New Guinea. On the north of the Banda Sea these folds are also obvious and are continued in the northern mountain axis of New Guinea. But the eastern end of this line of folding is now cut across by the Pacific, into which it must at one time have extended. The paper also contains important evidence on the river system of Chinese Tibet.

PERIODICITY OF EARTHQUAKES.—Messrs. D. Mukiyama and M. Mukai, in a paper too brief to be quite clear (*Japanese Journ. of Astr. and Geoph.* vol. 1, 1922, pp. 49-54), indicate a general similarity in the deviation of the atmospheric pressure-gradient at the time of an earthquake from the mean pressure-gradient in each of four selected districts in Japan. The question of the influence of rainfall on earthquake-frequency is considered, as regards the Philippines, by the Rev. M. Saderra Masó (Bull. of the Weather Bureau for February 1921). He shows that in the western districts of both Luzon and Mindanao earthquakes are most frequent during the rainy season, but in the eastern districts of both islands during the dry season. Thus, though rainfall may have some influence, it cannot be the main determining factor in the frequency of earthquakes. The late Mr. Marshall Hall, in his study of the earthquakes of Jamaica from 1688 to 1919, suggested the existence of nearly forty earthquake-periods varying in length from about 10 to about 30 days in the different epicentres, especially one of about 21 days in the epicentre of the earthquake of 1907. These periods have been examined by Prof. Turner (Mon. Not. R.A.S., Geoph. Sup., vol. 1, 1923, pp. 31-50), who arrives at the interesting results that they are multiples of 21·00 minutes, and that the intervals between the means of these periods are also multiples of the same unit, or 0·0145843 day.

STRUCTURE OF BENZENE.—In the February number of the Journal of the American Chemical Society, Dr. M. L. Huggins discusses the structure of graphite, benzene, and other organic compounds from the point of view of X-ray measurements by Hull and by Debye and Scherrer. He concludes that graphite consists of layers of close-packed benzene complexes of the type proposed, from the point of view of organic chemistry, by Körner in 1874. This is built up of six tetrahedra, three on each side of a plane, with edges adjacent, and with the vertices alternately above and below the plane. On the assumption that similar close-packed layers are present in benzene and many of its derivatives, the dimensions of the benzene hexagon are computed from crystallographic data. The half length of this is 2·47 Å., the half-width 2·14 Å., and its area 15·84 $Å.^2$. The corresponding figures from Debye and Scherrer are 2·52 Å., 2·18 Å., and 16·47 $Å.^2$ The probable error in each case is about 1 per cent.

SPACE GROUPS AND CRYSTAL STRUCTURE.—With the development of such methods of studying the arrangement of the atoms in crystals as are furnished by the use of X-rays, the geometrical theory of space groups has become of the utmost importance. Until recently the work published upon this theory has been primarily directed towards the preparation of a statement of all the different kinds of symmetry which are crystallographically possible. Such a statement, when complete, must give all the possible ways of arranging points in space which, by their arrangement, express crystallographic symmetry. In his "Krystallsysteme und Krystallstructur" (Leipzig, 1891) Schoenflies gave an analytical expression for the results of this theory in its most general form, but, before it is applicable to the study of the structures of crystals, modifications of this original representation are necessary. First, there must be selected such a portion of the grouping that, in its calculated effects upon X-rays, it can be taken as typical of the entire arrangement. Secondly, the X-ray experiments which have already been carried out show that the number of particles (atoms) contained in the unit cell is commonly smaller than the number of most generally placed equivalent points of the space group having the symmetry of the crystal. The special arrangements of the equivalent points (upon axes, planes, and other elements of symmetry), whereby the number of most generally placed equivalent positions is reduced, are thus of great importance, and it becomes essential to be able to state all of them in any particular case. In his "Geometrische Krystallographie des Discontinuums" (Leipzig, 1919), Niggli has given the simpler of these special cases. The complete set of them, enumerated by R. W. G. Wyckoff, is now presented in "The Analytical Expression of the Results of the Theory of Space-Groups," in Publication 318 of the Carnegie Institution of Washington, 1922; price 3.25 dollars.

The Dyestuffs Industry in Relation to Research and Higher Education.[1]

By Dr. Herbert Levinstein.

Within one generation we have seen the small mechanics' institute in a provincial city develop into an institution of university standing, constituting a technological faculty giving degrees, with some of its professors sitting on the university senate. In one way or another London, Birmingham, Bristol, all the large cities, show the same change. It means that within this period an enormous change has taken place in the character and requirements of our industries, and consequently in the demand for highly trained young men. The industrial world has changed. The present characteristic of industry is the tendency towards large units, using as one of their weapons an intelligence department (a research department), equipped with every resource of science. This is in itself nearly as far removed from the Victorian system of industry as that was from its predecessor, and it is causing nearly as great a social change as the industrial revolution that followed on the introduction of machinery.

The scientific educational establishments in this country are fundamental to the whole structure. By the vitality and originality, by the number and the quality of our teachers, the world can judge of the capacity of Great Britain in the long-neglected scientific industries, of which dyestuffs and fine chemicals are pre-eminent.

The dyestuffs industry is what is loosely termed a key industry. Mr. Runciman, speaking in the House of Commons on November 27, 1914, said: "The combined capital of such operations of textile and other industries which require aniline dyes comes to no less than 200,000,000*l.*, and about 1,000,000 of our employees are either directly or indirectly interested in the adequate supplies of dyestuffs for their main industries." There were few people who questioned at that time the urgency and importance of producing within our own shores the commodities required to support so many staple industries. We were at war with Germany, on whom we had been dependent in peace time for 80 per cent. of our requirements, and at that moment it was necessary, both from an economic and military point of view, to replace at once those vanished supplies from home sources.

What happened after the War? In 1913 the dyestuffs industry in England supplied about 10 per cent. of the British consumption, which amounted in round figures to rather more than 20,000 tons. The factories were comparatively small, and the number of chemists proportionately few. By Armistice Day the two principal companies, already loosely united, employed some 7000 persons, nearly 300 of whom were academically trained chemists—an unheard-of number in this country. During the two years following the Armistice more than 25,000 tons of dyestuffs manufactured by this British company alone went into consumption in Great Britain.

The extraordinary prosperity in the textile trades at that period had its aftermath in the slump. In 1919, however, the employment provided by these trades, and the money brought into this country as payment for exports, were factors without which this country would not have readily recovered from the paralysis of war. The total value of the exports of printed and cotton dyed piece goods alone during 1919–20 amounted to 270 million pounds sterling. In October 1920 the British Dyestuffs Corporation alone employed some 8000 people, with a yearly wage roll of 1,600,000*l.* This company used 4000 tons of coal per week, 1000 tons of pyrites, and corresponding quantities of heavy chemicals and raw materials. These figures may be considered large in this country, where we are not so familiar with very large plants, but they are small compared with the aggregate of the German I.G.

Suddenly in October 1920 the slump fell upon the country. The position was made much worse by four factors. German production revived, considerable quantities of German dyes were imported as reparations, the Sankey judgment temporarily removed all protection from the home producer, and the rapid external depreciation of the mark temporarily made it difficult to compete with Germany in neutral markets. Stocks fell in value, large sums of money were lost, and the production of British companies fell almost to pre-war figures.

The dyestuff and fine chemical industries in this country, are by no means assured of a prosperous development. If the factories are allowed to decay, the staffs to be gradually diminished, the capital invested rendered unremunerative, our position will become less strong. At the moment, should the occasion arise, the factories and organisations created during the war years are a source of strength.

The developments of higher scientific education in this country, on which our scientific industry is based, tend to strengthen the national life in a way which may not be immediately obvious but yet quietly and unobtrusively may be of fundamental importance to the State. There is another reason of great importance in favour of a flourishing and progressive dye industry. The dye industry is a key industry to invention. Its importance as a factor in producing new inventions is well summarised by Mr. J. A. Choate, the author of an official American publication issued by the Alien Property Custodian of the United States Chemical Section:

"The Technical skill and equipment provided by a successful Dye Industry, furnishes the means, and almost the sole means, to which every nation must look for advances in the application of chemical science to practical undertakings. No other industry offers a livelihood to any such large numbers of highly trained scientific chemists nor any such incentive to continuous and extended research."

Any firm wishing to become a serious factor in the world's markets for fine chemicals and dyes must employ a number of research chemists. Existing products tend towards obsolescence, competition from other makers tends to lower their price, and new demands constantly arise and are satisfied or created by new products for which high prices can be obtained owing to their novelty and, at first, the absence of competition. In the long run that nation will predominate in this industry which brings out the best and the largest number of new products.

These research organisations are expensive. Why then did the Germans start in this race for new products? They found this kind of research to be extremely profitable to their shareholders. Consequently, it was developed, and they were able to bring out annually quite a number of new products which, pushed by enterprising salesmen in all markets, home and foreign, gradually became established branches of manufacture in Germany.

Research for new products costing no more than the old, but for which the public will pay a higher price, is intimately wrapped up with the question of patents. Without the prospect of a monopoly for a term of years, and the lure of high profits, this kind of

[1] From a paper read before the Association of Technical Institutions on March 3.

work would not be undertaken on a comprehensive scale. Unfortunately, the monopolies granted in our country in the past for this kind of work were granted to German industries, and not to our own, and large profits were made out of British patents by the German dyestuff works. A similar research system, if sufficiently supported on the commercial and technological side and directed with sufficient knowledge of the requirements of the industry, and with some imagination, can be made to pay in England just as in Germany, where this combination existed. It is important to remember that firms employing this modern commercial weapon were large, for the amount of money that can be spent on research is a function of the turnover.

It is further true that to build laboratories, to engage for them a number of chemists, are not alone sufficient for our success.

If the stream of chemical invention can be induced to flow in this country in the future not less sluggishly than in Germany, we shall gradually build up new industries as the Germans built up theirs.

In this country we rely too much on our staple industries and look too little for new inventions to find food and employment for our people. In the Report of the Department of Scientific and Industrial Research, 1921–22:

". . . It is well recognised that for four-fifths of their food and for a great part of the necessary raw and semi-manufactured materials for industry the people of these islands are dependent on supplies from overseas. These supplies can only be obtained if this country is able to carry on its exporting industries in future with greater efficiency than the rest of the world."

The Department spent in this year more than half a million pounds with this purpose in view, and provision is made for expenditure on a similar scale for the current year. Under its auspices no less than 24 Industrial Research Associations have been formed, of which 22 are licensed by the Department, and received more than 86,000*l.* in grants during the year in question. Broadly speaking, the work of the Department and of the Research Associations with which it collaborates is to ensure the best utilisation of our natural resources and of the raw materials which we buy from abroad for our staple industries, with the view of increasing the efficiency of those industries and enlarging the demand for their products in customer countries.

This work does not replace that of private firms, but is complementary to and ought to stimulate it. There is a radical difference between industrial research carried out by a company and that by a Research Association, or by a Department of State. Patents taken out by chemists who receive part of their emoluments from the Department, belong apparently to the Government. Patents which may be taken out by a Research Association would presumably be available for all subscribers and could not easily become a profitable monopoly for any one member. For this reason it appears likely that in the future, as in the past, the dyestuffs industries and the allied fine chemical industries will be the main source from which chemical discoveries will be transferred from the laboratory to the factory.

Running through all this is one common factor which must be realised if the expectations of the State are to be satisfied. The industry must be big. There must be large factories containing plant capable of producing great quantities of organic chemicals, staffed by an adequate number of experienced and well-trained chemists. Moreover, the factories must be growing. It is an industry which cannot succeed if it be static. It must be ever increasing its plant and the number of its chemists and ever spreading its tentacles wider and deeper into the markets of the world.

It follows that if the industry is successful there will be a continual flow of students from the universities and technical schools to the industry. Two distinct classes of chemical students are required: (*a*) for factory and research, and (*b*) for the dyehouse and technical sales. It is customary in aniline dyestuff factories to recruit the chemists for plant supervision from their own research department. The young chemist engaged on leaving the university is first placed in the research department for at least a year before a permanent engagement is made. The training required of a dyestuff works chemist is usually identical, whether he intends to devote himself afterwards purely to research, or, as in the majority of cases, to become actually employed in the factory. It is of the first importance that chemists should have a good general secondary education. After taking his degree the student should cary out, under direction, original work for one or, preferably, two years. What branch of organic chemistry he studies is comparatively immaterial. A special knowledge of dyestuffs chemistry is not very important.

Undoubtedly a knowledge of chemical engineering is useful, but subjects added, however useful, will be at the expense of chemistry. The recent formation of the Institution of Chemical Engineers is welcome. Good chemical engineers are invaluable in any chemical industry, but, above all, good organic chemists are wanted in the dyestuff industry.

There is also a considerable demand for another type of chemist. All aniline dye works have a dyehouse which fulfils a treble function—the control of the production, the valuation of new specimens sent in from the research department, and the supply to the sales organisation of technical information and assistance in the application of dyestuffs. The technical salesman is a person of great importance in the industry. He should preferably take a pure or technological science degree, followed by a course in dyeing, printing, paper-making, etc., at a technical college. There is a constant demand for such men in a flourishing dyestuffs industry, the more so as the experience obtained in the experimental dyehouse is so varied, that such men are afterwards sought for as managers or as assistant managers in print-works, dyehouses, paper-works, and the like.

The foundation stones of our scientific industries were laid by those responsible for the creation of our great technical institutions and University Colleges. If that is so, we should expect to see during the years which have elapsed since 1914 a corresponding development in the chemical schools of this country. The progress in the study, teaching, and research in pure chemistry has been at least as striking as the progress of those sections of chemical industry such as fine chemicals and dyestuffs in which we were not particularly strong before the War. Twenty or thirty years ago the German organic schools were as pre-eminent in research and in teaching as the German dyestuff and fine chemical industry. To-day one may fairly say that there are several organic chemical schools in this country equal to that of any organic chemical school in Germany. Brilliant original work is being done here. Students are attracted to schools where good research is being done, and so round each head is formed a coterie of young men deriving inspiration from their chief, to strengthen the ranks of industry. Probably there has never been such a concentration of chemical talent as that which gathered round A. von Baeyer in Munich thirty or forty years ago, but something of the kind is happening in Great Britain to-day, and not in one centre alone.

Thirty years ago, institutions comparable, for example, with the Federal Polytechnic at Zurich or the Technical High School of Charlottenburg did not exist in Great Britain. The scale on whch they were designed, their large staffs of distinguished teachers, the number of full-time students, students who had remarkably good secondary school training and had passed a rigorous entrance examination, astonished all English visitors. The English organic chemist with industrial experience was equally astonished at, for example, the Leverkusen or the Badische factories. These factories differed from the corresponding English factories in scale, in the size of the buildings, their staffs, their financial results, just as the British schools differed from the corresponding German institutions.

The number of students taking a degree in pure science at 17 English and Welsh Universities in 1913–1914 was 1867. In 1921–22 the number was 4575, *i.e.* about two and a half times the 1913–14 number. At the University of Cambridge the figures were as follows:

	1913–14.	1921–22.
Number of chemical students working	498	804
Research workers	10 (about)	29
Staff, including professors . .	25	43

The growth of the dyestuffs industry within this period is well known, and there has been a similar growth in the fine chemical industry. In 1913 some 100 fine chemicals were made in England, whereas 4000 are now being made; for every ton of fine chemicals made here in 1913 exactly 2½ tons are made to-day. This ratio is identical with that of the increase in science students taking a degree course.

Is it possible that this parallel growth in our teaching institutions and newer industries is accidental? The figures are symptomatic, but they indicate that the strength of our higher teaching bodies is a measure of our strength in the industries depending on invention.

It may be said that there has been in Germany, too, and no doubt in other countries, a great increase in the number of students at their High Schools. In part this is one of the social changes brought about by the new industrial revolution.

The increase in the number of chemical students is partly due to the publicity given in 1914 to the renascent dyestuffs industry, and to the support given by public opinion and by the Press for the first time in our history to those engaged in these industries. These industries open out to a young man who has a love of research the opportunity of earning a livelihood in a most interesting way, with the added possibility, if his inventions prove commercially successful, of earning considerable profits. Before the War it was difficult to live by research.

It is probable that the grants made by the Department of Scientific and Industrial Research have tended to increase the number of chemists undertaking training, "for the underlying object of the Scheme of Grants is the output of an increased number of trained scientific investigators." At the same time, the Department has done much to increase the possibility of finding employment for chemists. The Department, including its headquarters staff, boards and committees, Fuel Research Station and the Research Associations, already employs 78 chemists, none of whom were employed in 1913, at salaries ranging from about 250*l*. to 2000*l*., the majority between 350*l*. and 700*l*. In other Government Departments, too, there has been a great increase in the number of chemists employed. In 1913–14 the staff of the Government Chemist consisted of 48, with a salary range of 120*l*. rising to 1500*l*. The majority of the posts ranged from 120*l*. to 500*l*. In 1921–22 there were 75 posts, ranging in salary from 300*l*. to 700*l*. At the War Office in 1913–14 there were 22 posts and 2 teaching posts at the Ordnance College. The salary range was about 150*l*. to 550*l*. In 1921–22 there were 93 posts, with salaries ranging from 300*l*. up to 1200*l*., but with the majority falling within a range of 300*l*. to 700*l*. At the Admiralty in 1913–14 there was one inspector of cordite, in addition to the teaching staff at the Royal Naval College at Greenwich and the schools at Dartmouth and Osborne. In 1921–22, in addition to these teaching staffs, there were 20 posts with salaries of from about 150*l*. to 600*l*. The total number of chemists who can to-day find employment in the service of the above Government Department is thus 193 more than in 1913.

In the 1921 report of the Department it is stated that of the 132 students receiving grants 24 found employment under the State or under State-aided research institutions, 22 went into the teaching profession, and none went into industry, no doubt owing to the slump in trade.

If our fine chemical industries begin to increase their staffs regularly, as in prosperous years they will, the situation will be improved, but it is to the general trade of the country and not to the specifically chemical industries that we must look to give employment to all those who have taken a chemical degree.

Large Telescopes and their Work.

SIR FRANK DYSON'S presidential address to the Optical Society on February 8 on the subject of "Large Telescopes" dealt with the progressive advance of astronomy so far as it was brought about by the increased optical powers of telescopes. The Copernican system was established before the discovery of the telescope, but Galileo's telescope removed many difficulties and commanded its acceptance. The great telescopes of Herschel revealed the vast extent and variety of the stellar system. At the beginning of the nineteenth century, excellent achromatic telescopes of 6 inches were made by Fraunhofer and Merz, and in 1824 an object glass of 9·6 inches was made for Struve at Dorpat with which he carried out his great work on double stars.

When the Russian National Observatory at Polkovo was founded a 15-inch glass was obtained from the Munich firm, and this was the largest refractor in the middle of the nineteenth century. The large telescopes of this time were the reflectors of Lord Rosse and Lassell, and with them the heat from the moon was measured and new satellites of Uranus and Neptune discovered. A new development in reflecting telescopes came with the process of silvering on glass, and gradually these superseded speculum. In England in the early 'eighties photography of nebulæ began with Common's photograph of the Orion nebula, and was pursued by Isaac Roberts. The manufacture and mounting of reflectors was brought to a high degree of perfection by Ritchey at the Yerkes Observatory, but it was with the Crossley reflector, made by Calver and presented to the Lick Observatory by Sir Edward Crossley, and remounted by Keeler, that most systematic work was done.

Meanwhile, larger refractors were being made. In 1868 one of 26 inches aperture was made by Cooke for H. S. Newall of Newcastle. This was soon followed by large telescopes in America by Alvan Clark, by Grubb in England, and the brothers Henry in France. In 1892 a 36-inch glass was made for the Lick Observatory by Alvan Clark, and a 40-inch for the Yerkes Observatory in 1897. These large telescopes led to the discovery of new satellites, the accurate determination of the sizes of planets and satellites, but their main work—used visually—was the discovery and measurement of large numbers of double stars, leading to a very satisfactory knowledge of the masses of stars. Used with the spectroscope, they gave the velocities of stars to and from the earth, and enabled the velocity of the sun among the stars to be determined as 19 kilometres per second. This result, in combination with measurements of angular motions of stars, served to give the mean distances of stars. Large photographic refractors have made possible the measurement of the actual distances of thousands of stars, leading to a much more complete view of the stellar system.

The discoveries made by the large 60-inch and 100-inch reflectors of Mt. Wilson and the 72-inch of British Columbia were also detailed, culminating with the measurement of the size of the disc of Betelgeuse and of several other stars by the interferometer as applied by Michelson.

Irish Sea Plankton.[1]

SIR WILLIAM HERDMAN, in an interesting paper recently issued, gives a summary of plankton researches in a single area extending over a period of fifteen years, and compares the results in each year in such a way that certain general facts are at once apparent.

The object of the investigations was twofold: "(1) To study the distribution of the plankton as a whole, and of its various constituents during the year; and (2) to arrive at some estimate of the representative value of the samples collected in the plankton nets."

The results show very clearly that the distribution of life in the sea is not uniform, but that the organisms appear in patches. Although this applies to a certain extent to all the plankton, it is especially the case with the copepods, which are frequently present in large swarms in one place, while possibly only a short distance away few or none occur. This naturally affects the distribution of other organisms feeding on the copepods, especially fishes, and is of fundamental importance. The diatoms were found to be more evenly distributed both vertically and horizontally during their maximum in the spring than at any other time. Comparing the records for the fifteen years (1907–21), there is always this spring maximum of phytoplankton (chiefly diatoms), which may range from March to June and reach to hundreds of millions in one haul, a dinoflagellate maximum, in much smaller numbers, coming on about a month later; and later still, a copepod maximum ranges from June to October. In late summer or autumn each group may have a second smaller maximum in the same order.

That the bulk of the plankton consists of a small number of genera, chiefly diatoms and copepods (and only a few species of copepods), is well established, and these few form the chief food of most of the marine animals. So far as fishes are concerned, copepods are by far the most important food of the young stages, and also of the plankton-eating adults; but as most copepods are predominantly diatom feeders the presence of diatoms is quite as important to the fish as to the copepod. With regard to the phytoplankton, however, Sir William Herdman apparently regards it as the direct food of many larval fishes, at any rate of the plaice in its infancy, which he has seen with its stomach full of diatoms.

The diatom maximum occurs usually just before the time when most of the fish larvæ begin to be abundant, and the copepods follow. These plankton investigations are thus of great importance relative to the food of fishes.

Dr. Johan Hjort suggests that large mortality among the fish larvæ may occur because of the lack of suitable food at the time when they begin to feed. In the present plankton investigations, together with data gathered from experiments in the plaice hatching at the Port Erin Biological Station, it is shown that diatoms are abundant usually a short time before the very young plaice are set free; but in four out of thirteen years the diatoms were late, and in these years it is possible that the young fishes may not have found enough to eat. "The evidence so far seems to show that larvæ set free as late as March 20 are fairly sure of finding suitable food: but if they are hatched as early as February they run some chance of being starved."

While discussing fully the phytoplankton in relation to fish larvæ very little is said of the zooplankton other than copepods, and one would infer from the conclusions that it is only the diatoms which are of importance as young fish food in the spring. It is, however, probable that in spite of the fact that more diatoms than anything else are present, yet the zooplankton is really of more direct value as food for the larval and post-larval fishes: for example, cirripede nauplii and mollusc larvæ besides copepods, the latter, although not at their height in the spring, yet occurring in large numbers.

Sunlight is shown to play a very important part in the growth of the plankton. In the daytime, however, the largest hauls are usually not at the surface but at about five or ten fathoms, the depth varying with the meteorological conditions. It is regarded as probable that the spring phytoplankton maximum is due chiefly to the great increase of sunlight aided by the winter increase of carbon dioxide and other food matters. The rapid disappearance of the diatoms after the spring maximum is accompanied by a greater alkalinity of the water, and it is suggested that it may be due to the injurious effect of their own metabolism. May not the explanation lie partly in the fact that the diatoms are eaten by an enormous number of pelagic animals coming on just after the diatom maximum?

As to the representative value of the samples collected in the plankton nets, it is shown that variation in the composition of similar hauls is great. These differences show clearly that the life in the sea is not spread evenly either horizontally or vertically, but everywhere occurs irregularly. Simultaneous hauls of similar nets were usually different in quality even if alike in quantity, and the same applied to successive vertical hauls in which the amount of organisms was much the same in each haul but different in kind.

In plankton investigations in which tow-nets are used, however carefully the experiments may be carried out, there is necessarily a great deal of inaccuracy, which is freely admitted and discussed. None of the numerical results can be absolutely exact, but when, by examining and recording these, certain phenomena are seen to repeat themselves year after year, we can at least feel sure that by making these careful quantitative experiments in connexion with numbers of hauls all carried out in an exactly similar way, we are approaching the solution of the general problems relative to the distribution of life in the sea.

M. V. L.

[1] "Spolia Runiana. V. Some Results of Plankton Investigations in the Irish Sea," by Sir William Herdman. Extracted from the Linnean Society's Journal—Botany, vol. xlvi., July 1922.

University and Educational Intelligence.

Bristol.—Dr. L. J. Russell, lecturer in philosophy at the University of Glasgow, has been appointed to the chair of philosophy which will be vacated by Prof. C. D. Broad at the end of the current session.

Cambridge.—The Duke of Devonshire has been elected High Steward of the University in succession to the late Earl of Plymouth. So far back as the fourteenth century a Cavendish held high office in the University, and the name of Henry Cavendish is perpetuated in the Cavendish chair of experimental physic.

Mr. G. S. Adair, scholar of King's College, Mr. P. M. S. Blackett, Bye-fellow of Magdalene College, and Mr. B. Ord, organ scholar of Corpus Christi College, have been elected fellows of King's College.

Leeds.—The Council has agreed with the University of Basle to a scheme of mutual recognition of certain courses and examinations in the case of students proceeding from either of these Universities to the other.

London.—Prof. A. V. Hill has been appointed as from August 1 next to the Jodrell chair of physiology tenable at University College. Prof. Hill was educated at Trinity College, Cambridge. He was Third Wrangler, and obtained a first class in physiology in the second part of the Natural Sciences Tripos. He was fellow of Trinity College from 1910 to 1916, and in the latter year was elected fellow of King's College. During the War he was director of the anti-aircraft experimental section of the Munitions Inventions Department and a member of the Inventions Committee. Since 1919 he has been professor of physiology in the Victoria University of Manchester. He is the author of a number of papers in the Proceedings of the Royal Society and the *Journal of Physiology*.

Mr. W. J. Perry has been appointed as from August 1 next to the University readership in cultural anthropology tenable at University College. He was educated at Selwyn College, Cambridge, and studied ethnology under the late Dr. Rivers. Since 1919 he has been reader in comparative religion in the Victoria University of Manchester, and has also delivered courses on ethnology in the department of psychology of that University. He is the author of "The Megalithic Culture of Indonesia," "The Children of the Sun," and "The Origin of Magic and Religion," and of numerous papers on ethnological and anthropological subjects.

Dr. B. Malinowski has been appointed as from August 1 next to the University readership in social anthropology tenable at the London School of Economics. From 1914 to 1918 he was engaged in anthropological field-work in Eastern New Guinea. He is the author of "The Family among the Australian Aborigines" and "Argonauts of the Western Pacific," and of a number of articles on anthropological and allied subjects.

The following doctorates have been conferred:—*D.Sc. in Agricultural Chemistry*: Mr. N. M. Comber, an external student, for a thesis entitled "The Flocculation of Soil Particles considered in relation to the Action of Lime and the Constitution of the Soil," and other papers. *D.Sc. in Physics*: Mr. E. T. Paris, an external student, for a thesis entitled "On Doubly-Resonated Hot-Wire Microphones," and other papers.

The Senate has resolved to hold a reception for the sixth triennial congress of the Société Internationale de Chirurgie, which will be held in London in July next.

Manchester.—The chairman of the council, Sir Frank Forbes Adam, has received from the Viscount Morley of Blackburn a letter asking leave, on account of the growing weight of years, to withdraw from the office of Chancellor of the University, the resignation to take effect from April 30. The council passed a resolution expressing regret at losing the Chancellor, and deep appreciation of the honour which he has conferred on the University during his tenure of office.

The council passed the following resolution: "The council have heard with deep regret of the death of Sir William Thorburn, professor-emeritus of the University. They desire to record their sense of his great services as an administrator, a teacher, and an investigator, his eminence as a surgeon, and the whole-hearted devotion with which he sacrificed himself in the service of his country. His sterling integrity inspired respect in all his colleagues and students. The council desire to convey to his relatives their profound sympathy with them in their loss."

The following appointments have been made:—Mr. F. Fairbrother, to be lecturer in chemistry; Dr. D. S. Sutherland, to be clinical lecturer in infectious diseases; and Dr. R. Marsden, to be hon. clinical lecturer in tuberculosis.

Mr. W. H. Allen, past-vice-president of the Institution of Mechanical Engineers, has presented to the Institution the sum of 1000*l*., and has desired the council to select a suitable student or graduate to receive this grant, in three annual instalments, at Trinity College, Cambridge. Applicants should preferably be between 20 and 25 years of age, and must be able to satisfy the council that they possess such educational qualifications as will ensure that they would derive the maximum possible benefit from an honours course in engineering (Mechanical Science Tripos) at Cambridge. Preference will be given to an applicant who has had some practical workshop training. Applicants must be prepared to go into residence at Cambridge in October 1923. Applications should be made on a form to be obtained from the secretary of the Institution, and must be returned not later than May 1.

The Ministry of Agriculture and Fisheries announces that a number of scholarships under the scheme approved last year for establishing scholarships and maintenance grants for the sons and daughters of agricultural workmen and others are offered for award for the session commencing in October next. The scholarships are provided out of the special fund for agricultural development voted by Parliament under the Corn Production Acts (Repeal) Act, 1921. They are of three kinds: Class I. scholarships, tenable for three years at Oxford, Cambridge, or other Universities, enabling students to attend degree courses in agriculture; Class II. scholarships, tenable for two years, at certain university departments of agriculture and agricultural colleges; and Class III. scholarships, tenable for one year at farm institutes and similar institutions. Candidates for Class I. and Class II. scholarships must be at least 17 years of age on June 30, 1923, and must satisfy the selection committee that they have reached a sufficiently high standard of education to derive educational benefit from the courses of instruction. For Class III. scholarships candidates will be required to furnish evidence of their acquaintance with practical agriculture, and they must be at least 16 years of age on June 30, 1923. Applications should be lodged with the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1, not later than May 14.

Societies and Academies.

LONDON.

Royal Society, March 22.—L. T. **Hogben** and F. R. **Winton**: The pigmentary effector system. III.—Colour response in the hypophysectomised frog. After complete removal of the pituitary gland, the melanophores remain permanently contracted, even when the frogs are exposed to conditions which are optimum for darkening of the skin; they can be made to expand by pituitary extract, but the animals regain pallor under conditions which invariably produce darkening in the normal or partially hypophysectomised (anterior lobe alone) frog. The minimum dose of pituitary extract for melanophore expansion was compared in normal and pituitaryless frogs. The experiments provide evidence that: (1) the rhythm of colour change in normal life is correlated with fluctuating amounts of pituitary secretion, and (2) direct nervous influences do not play a significant rôle in co-ordinating pigmentary responses in Amphibia.—H. R. **Hewer**: Studies on amphibian colour change. The presence of "frayed" ends to processes and isolated granules and irregular edges to the concentrated mass of granules precludes any theories postulating amœboid movement of cell processes. This is supported by (1) irregular movements of the granules; (2) slight massing of granules towards tips of processes in dispersed phase; and (3) stained sections of skin. Adult *Rana temporaria* respond, similarly to other Amphibia, to factors of normal environment. Dryness and light background cause concentration; moisture and dark background dispersion. Low temperature causes dispersion and medium temperature concentration. Higher temperatures appear to have an intermediate effect. Neither nitrogen nor hydrogen produced any effect during three hours; carbon dioxide did not affect colour before proving toxic; oxygen produced concentration in melanophores; chlorine changes melanin granules to a red colour.—J. **Walton**: On Rhexoxylon, Bancroft: a Triassic genus of plants exhibiting a liane-type of vascular organisation. The genus Rhexoxylon was instituted in 1913 for a fossil stem from South Africa. The evidence given by certain structural details was in favour of attributing it to the Palæozoic group of polystelic arborescent plants, the Medulloseæ. The study of additional specimens from South Africa shows that the organisation of the vascular system resembles very closely that of certain modern South American Lianes, especially in the anomalous methods of secondary thickening of the axis. Histologically, the secondary wood of Rhexoxylon resembles that of the group Dadoxyla, characteristic of the southern botanical province during the latter part of the Palæozoic era. Possibly Rhexoxylon, as a specialised ecological type, bore much the same relation to the gymnospermic Dadoxylon stock as the modern Liane bears to the angiospermic group at the present day, and the occurrence of an anomalous type of vascular system in the modern Liane is an example of a repetition, in a distinct phylum, of a specialised organisation evolved in Palæozoic times. The fossil stem *Antarcticoxylon priestleyi* Seward, from South Victoria Land, Antarctica, has some of these peculiarities, and its occurrence in the Beacon Sandstone Series of Antarctica points to a probably close relationship between portions of this series and the Stormberg Series of South Africa, from which came the majority of specimens of Rhexoxylon.—G. **Hewett**: The Dusuns of British North Borneo. The Dusuns themselves claim descent from the Chinese who settled in North Borneo. The general political conditions in Asia during the thirteenth century led to the invasion of North Borneo by Kublai Khan. The Bruni tribute was transferred from Majapahit to China, and the Chinese acquired the throne of Bruni. The Bruni government based its claim to the whole territory of North Borneo on the marriage of Sultan Akhmed to the Chinese daughter of Ong Shin Ping, who was in all probability the occupant of the Bruni throne at the time. The Chinese occupation and development probably lasted some four hundred years.—M. **Tribe**: The development of the hepatic venous system and the postcaval vein in the Marsupialia. The development of the hepatic veins is subject to variation. Two venous rings of vitelline origin are transformed into a spiral vessel encircling the gut. In most genera the left allantoic vein becomes the more important and in some genera it anastomoses with the spiral vessel. The mesenteric vein is probably derived, in part, from the caudal venous ring. The postcaval is derived from three sources. The postrenal section takes origin from the paired supracardinal plexus, the renal section from the subcardinal veins, the hepatic and prehepatic sections from the vitelline veins. The azygos and lumbar veins, and the suprarenal sinusoids, are derived from the supracardinal plexus. The left suprarenal vein is the persistent left subcardinal vein.—J. **Gray**: The mechanism of ciliary movement. III.—The effect of temperature. Between 0° and 33° C. the speed of the cilia on the gills of Mytilus increases with a rise in temperature, although the amplitude remains normal. Between 34° and 40° C. there is a marked falling off in the amplitude of the beat, followed by a reduction in speed. At 40° C. the cilia come to rest in the relaxed position. At 45° C. the cilia occupy the contracted position. The temperature coefficient of movement between 0° and 32·5° C. varies from 3·1-1·92. High temperatures have a destructive effect on individual cells of the epithelium. In well aerated tissue the oxygen consumption is directly proportional to the speed of the beat between 0°-30° C. At about 30° C. the initial oxygen consumption is not maintained, due to the disintegrative effect of the temperature on the epithelium. The effect of temperature on the activity of cilia is closely parallel to its effect on cardiac muscle.—E. **Ponder**: The inhibitory effect of blood serum on hæmolysis. The hæmolytic action of saponin is inhibited by the proteins of serum, and also, to a lesser extent, by the cholesterol. The action of the bile salts is inhibited by the proteins, and by the lecithin of the serum. The inhibitory power is fairly constant in man and animals, is altered by drying the serum, and is affected by bacterial action. A quantitative study of the inhibition produced by serum shows inhibition is probably due to the formation of a loose compound between the proteins of the serum and the hæmolytic agent. The inhibitory effect of hæmoglobin on hæmolysis produced by saponin and bile salts is considered. Probably the reaction which takes place between saponin or bile salts and red cells is a chemical one of the first order.

Royal Anthropological Institute, March 13.—Mr. H. J. E. Peake in the chair.—Miss M. Edith **Durham**: "Bird Men" and kindred customs in the Balkans. On the western side of the Balkan peninsula a considerable part of the population still identifies itself with birds. Thus the Albanians call themselves Shkypetars, and derive the word from Shkyp, an eagle, and regard the killing of an eagle as unlucky. In Montenegro also there is a strong bird tradition. Here it is the "soko," the falcon. Officers address their men as "my falcons," and Montenegrins hail each other as falcons. In the traditional ballads of the people the falcon appears as the messenger. Between the popular hero, Marko Kralyevitch, and the falcons there exists a very great friendship. In other ballads the hero actually refuses to kill a falcon on the ground that it is kin to him, and in yet another the Tsar's daughter is with child by a "bird man," who is a falcon by day and who dies when his wings are taken from him, killed by the jealous Vilas who, in their turn, fly about in the guise of swans. The falcon and the swans dwell on the mountains where the sun rises, and magic lights herald their coming and going. The tale is obviously the remains of some ancient beliefs about the sun and the birds and recalls the quaint bronze bird chariots of the sun, found at Glasinatz in Bosnia. Ballads also describe warriors of the Middle Ages dressing themselves up with eagle's tails and wings, and a print from a book on Turkey by Nicholas de Nicolay (1568) shows such a warrior. Plume-wearing is extinct, but in the Eagle dance of the Montenegrin he leaps high off the ground, flaps his arms, and yells.

Paris.

Academy of Sciences, February 26.—M. Albin Haller in the chair.—The president announced the death of E. Ariès, corresponding member for the section of mechanics.—André **Blondel**: The calculation of the forced oscillations of an electrogenic group (or of an analogous apparatus) turning with a constant mean velocity, but submitted to periodic variations of the motor couple at the same time as an elastic resisting force variable with the angle of deviation.—M. Louis Gentil was elected a member of the section of geography and navigation in succession to the late M. L. Favé.—Boris **Delaunay**: The geometrical interpretation of the generalisation of the algorithm of continued fractions given by Voronoï.—Maurice **Lecat**: Expression of the most general determinants of a matrix as a function of the sections.—C. E. **Traynard**: Surfaces of the fourth degree with fifteen double points and singular Abelian functions.—René **Lagrange**: Varieties with zero total torsion in Euclidian space.—Stanislas **Millot**: A criterion of the probable value of certain experiments.—J. **Grialou**: The rotational, but permanent, movement of liquids possessing viscosity, when the trajectories are plane and vertical.—C. **Flammarion**: The increase of brightness of the star β Ceti. A sudden increase in the brightness of this star was notified on February 13 by Mr. Abbott from Athens. This has been confirmed by observations at Juvisy by the author.—Emile **Belot**: The collective and discontinuous evolution of stars and nebulæ.—M. **Holweck**: The optical properties of X-rays of great wave-length. Experimental evidence has been obtained of the diffraction of X-rays of a minimum wave-length $\lambda = 47$ Å (effective wave-length $\lambda = 60$ Å approx.). Evidence of the reflection of X-rays by a polished bronze surface is also given.—G. **Laville**: The propagation of electromagnetic waves, maintained along two parallel wires. The theories of Kirchhoff and Lord Kelvin appear to explain the phenomena of propagation as exactly as the more complicated theories of Sommerfeld and M. Mie.—V. **Ylöstalo**: The measurement of high-frequency coefficients of self-induction.—H. **Copaux** and Ch. **Philips**: The heat of oxidation of glucinum. A correction of an earlier result; the new figure is 131·3 calories in place of 151·5 calories.—Paul **Riou**: The velocity of absorption of carbon dioxide by ammoniacal solutions. Curves are given showing the influence of additions of ammonium chloride, sodium bicarbonate, and sodium chloride to the solution, and of changes of temperature.—L. J. **Simon**: The action of methyl sulphate and of potassium methyl sulphate on monobasic organic acids in the absence of water. The interaction of anhydrous organic acids with these substances in certain cases may be used with advantage for the preparation of methyl esters.—A. **Roche** and V. **Thomas**: Researches on picryl sulphide. Study of the binary mixture: tolite-picryl sulphide. This explosive was extracted from German bombs: it is very stable and stands a compression of 500 kilograms per square centimetre without losing its property of detonating.—Raymond **Delaby**: The preparation of some ethers and glycidic derivatives of alkyl glycerols.—Y. **Milon**: The fauna and age of the carboniferous limestone of Saint-Segal (Finistère).—Jean **Piveteau**: The morphology of the scapular arc of the Permian reptiles of Madagascar.—Methodi **Popoff**: The respiratory system of plants. According to the generally accepted view the respiration of plants is confined to the leaves. This view leads to difficulties, and it is suggested that plants have a respiratory system presenting analogies, from the physiological point of view, with the respiratory system of animals.—Marcel **Mirande**: The proteolipoid nature of the sterinoplasts of the white lily. By the application of various microchemical tests the central body of the sterinoplasts has been proved to be of a lipoid nature, covered with a thin external layer of proteid material.—P. **Delauney**: New researches relating to the presence of loroglossin in native orchids. Loroglossin has been isolated, up to the present, from 17 species of native orchids belonging to five different genera.—Paul **Becquerel**: Observations on the necrobiosis of plant protoplasm with the aid of a new reagent. The reagent consists of methylene blue (2 parts), Bismarck brown (1 part), and neutral red (1 part) in aqueous solution ($\frac{1}{10000}$). The death of the cell is accompanied by definite colour changes in the parts stained by this reagent.—G. L. **Funke**: Biological researches on plants with creeping stems.—Marc **Fouassier**: The influence of copper on the lactic fermentation. The minute traces of copper dissolved by milk in contact with that metal have a distinctly retarding influence on the growth of the lactic organism.—A. **Desgrez** and J. **Meunier**: The mineral elements of the blood.—L. **Cuénot**, R. **Lienhart**, and M. **Mutel**: Experiments showing the non-heredity of an acquired character.—Ed. **Lesné** and M. **Vaglianos**: The utilisation by the organism of the C vitamins introduced through the parents. From experiments on rabbits the authors conclude that it does not matter whether the C vitamins are introduced by ingestion or by injection, the beneficial effect is the same in either case.—A. **Pézard**, Knud **Sand**, and F. **Caridroit**: The experimental production of bipartite gynandromorphism in birds.

March 5.—M. Albin Haller in the chair.—G. **Urbain** and A. **Dauvillier**: The coexistence of celtium (element 72) and the yttria earths. The view of Coster and Hevesy regarding the improbability of element 72 being associated with the rare trivalent earths is said to be negatived not only by the work of the authors but also by the discovery of this element by Goldschmidt and Thomassen in malakon and in alvite.—Charles **Moureu** and Charles **Dufraisse**: Auto-oxidation: attempt to explain the mechanism of anti-oxygenisers.—André **Blondel**: Elementary calculations of the couples damping alternators with a forced regime in the theory of two reactions, when the resistances of the armature are neglected.—C. de la Vallée **Poussin**: Quasi-analytical functions with real variables.—Ph. **Glangeaud**: The earthquake of October 12, 1922, in the Creuse and the Limousin, and some earthquakes in the north-west of the Central Massif. A map of the district over which the shocks were felt is given, showing also the lines of the faults in the geological strata. These earthquakes in the Central Massif are due to slipping along the old lines of the faults.—M. Gabriel Bertrand was elected a member of the section of chemistry in the place of the late H. Georges Lemoine. —Georges **Darmois**: The local integration of the equations of Einstein.—F. **Defourneaux**: A category of polynomials analogous with electrospherical polynomials.—N. **Abramesco**: The auto-generation of curves.—Henri **Milloux**: The growth of integral functions of finite order and their exceptional values in the angles.—Kyrille **Popoff**: The pendulum of variable length.—J. **Haag**: The interior problem of Schwarzschild, in the case of a heterogeneous sphere. —B. **Salomon**: The gryoscopic analogies of synchronous and asynchronous electrical machines and the transposition into mechanics of certain diagrams of electrotechnics.—MM. **Huguenard, Magnan**, and A. **Planiol**: An apparatus giving the instantaneous direction of the wind. This is a modified compensated hot-wire anemometer. By using this and the compensated hot-wire instrument for measuring wind velocity, both the instantaneous direction and velocity of the wind can be recorded on the same chart. Examples of such records are reproduced, and their bearing on problems of flight without motors indicated.—Jean **Chazy**: A correction derived from the theory of relativity to the Newtonian time of revolution of the planets.—J. Ph. **Lagrula**: Test of the rapidity realisable in equatorial measurements of small planets with a telescope provided with a photo-visual comparator and some additional accessories.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the fourth quarter of 1922. The results of the observations taken on 61 days during this quarter are summarised in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Henri **Bêghin** and Paul **Monfraix**: A new gyrostatic compass. This instrument, composed of a system of three gyrostats, has been specially designed to neutralise the deviations produced by the motion of the ship.—F. W. **Klingstedt**: The ultra-violet absorption spectra of the cresols.—A. **Dauvillier**: The high frequency spectrum of celtium. Reply to a criticism by D. Coster and G. Hevesy.—André **Charriou**: The removal of acids from solution by precipitates of alumina. A study of the removal of chromic acid by aluminium hydroxide, and of the means of purifying the precipitate by washing with suitable reagents.—R. **Locquin** and **Sung Wouseng**: The preparation of various pinacones by the action of alkyl magnesium compounds on some α-hydroxy-methyl ketones. Details of a generally applicable method for preparing bitertiary α-glycols of the type $RR'C(OH)—C(OH)R''(CH_3)$.—Pauline **Ramart**: A molecular transposition in the pseudo-butyl-diphenylcarbinol series. A study of the compounds produced by the action of acetic anhydride and acetyl chloride upon the alcohol $(C_6H_5)_2 . C(OH) . C(CH_3)_3$.—Emile **André**: The separation of methyl oleate and methyl linoleate by fractional distillation. The separation is difficult, owing to the tendency of the linoleate to form polymers.—A. **Mailhe**: The decomposition of the aryl formamides. A new method of preparation of substituted ureas. The vapours of formanilide passed over finely divided nickel at 400°-410° C. give some aniline and diphenylurea. The formotoluides behave similarly.—Henri **Longchambon**: The study of the spectrum of the triboluminescence of some substances. Crystals of tartaric acid when broken give a band spectrum of nitrogen similar to that obtained from sugar. Crystals of cadmium sulphate, uranium nitrate, and fluor spar also show nitrogen bands. The light from the uranium salt, which has a colour differing from the other, shows the four green fluorescence bands of uranium nitrate.—E. **Schnæbelé**: The granites of the Champ du Feu (Vosges).—Léon **Bertrand** and Antonin **Lanquine**: The co-ordination and origin of the Pyrenees-Provençal structural units in the south-west of the Maritime Alps.—Pierre **Bonnet**: The tectonic relations of the gneiss and coal measures in the northern Morvan.—Henry **Joly**: The constitution of the Jurassic at Torrelapaja and Bordejo (Celtiberic chain, provinces of Saragossa and Soria, Spain).—E. **Bénévent**: The mistral on the coast of Nice. The freedom of Nice from the mistral is not due to its sheltered position, but to its situation with respect to the trajectories of the barometric minima.—Joseph **Lévine**: Triatomic hydrogen and meteorological depressions.—J. **Beauverie**: Influence of the rainfall during the "critical period" of wheat on the yield. Provided the rainfall during the "critical period" is below a certain amount, the yield of wheat is roughly proportional to the rainfall. —A. A. **Mendes-Corrêa**: The proportions of the limbs in Portuguese. The Portuguese, from the point of view of the proportions of their limbs, are of a clearly European type.—Henri **Piéron**: The propagation of luminous stimulation of the retina to the cerebral outer layers.—Marc **Romieu**: The histological study of the testicle of *Orthagoriscus mola*.—R. **Hovasse** and G. **Teissier**: Peridinians and Zooxanthelles.—C. **Levaditi** and S. **Nicolau**: The filtration of neurotropic ultravirus through collodion membranes. The virus of rabies, encephalitis, herpes, and neurovaccine can be filtered under pressure through collodion membranes. The filtrates vary in toxic power; not only from one membrane to another, but also according to the nature of the virus.

Official Publications Received.

Report of the Commissioner of Education for the Year ended June 30, 1922. Pp. iii+32. (Washington: Government Printing Office.)

Report of the Marlborough College Natural History Society (founded April 9th, 1864) for the Year ending Christmas, 1922. (No. 71.) Pp. 72+3 plates. (Marlborough.)

Forest Bulletin No. 51: An Investigation of certain Factors concerning the Resin-tapping Industry in *Pinus longifolia*. By H. G. Champion. Pp. 20. (Calcutta: Government Printing Office.) 8 annas.

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Extracted from Year Book No. 21 for the Year 1922.) Pp. 266-309. (Washington.)

Diary of Societies.

WEDNESDAY, April 4.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.—Dr. S. White: Physiological Standardisation.—B. S. Evans: An Investigation into the Chemistry of the Reinsch Test for Arsenic and Antimony, and its Extension to Bismuth.—Dr. G. W. Monier-Williams: The Estimation of Boric Acid in "Liquid Eggs" and other Foodstuffs.

Entomological Society of London, at 8.

FRIDAY, April 6.

Royal Society of Arts (Indian Section), at 4.—G. R. Clarke: Postal and Telegraph Work in India.

Philological Society (at University College), at 5.30.—Prof. W. A. Craigie: Dictionary Prospects.

Institute of Marine Engineers, Inc., at 6.—Annual Meeting.

SATURDAY, April 7.

Gilbert White Fellowship (Annual General Meeting) (at 6 Queen Square, W.C.1), at 2.—Sir David Prain: Presidential Address.

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" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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Problems of Tuberculosis.

IN the *Empire Review* for March Dr. Leonard Williams brings forward the perennial theme of the Spahlinger treatment of tuberculosis. This "treatment" has been the subject of extravagant and repeated press notices since 1914, and when it is shorn of its decorations, what does it amount to? Merely that M. H. Spahlinger has made, or his friends have made for him, a number of categoric statements, unsupported by proofs of the kind demanded in scientific work, that he can cure tuberculosis in man and animals. In a relatively small number of cases of consumption, clinicians have stated that the disease was arrested. Dr. Leonard Williams, an ardent supporter of M. Spahlinger, cites the communication of the latter to what he calls the "high-browed Paris Academy of Sciences." This communication (1921, t. 172, p. 494) occupies exactly one page and four lines, and is a reiteration of former statements without any evidence whatsoever that they are correct or of essential scientific value.

Dr. Leonard Williams also quotes April 28, 1914, as memorable in the history of tuberculosis, for on that day Prof. Letulle presented to the French Academy of Medicine a communication entitled "Traitement de la tubérculose par la méthode Henri Spahlinger." In the *Bull. de l'Acad. de Méd.* (1914. 3. s. t. 71, p. 610) we find that the communication occupies exactly eighteen lines, and was a preliminary note addressed to the Academy by Dr. E. Lardy of Geneva and Drs. Colbeck and Leonard Williams of London. Prof. Letulle was charged to examine the note, but up to date we have been unable to find any further reference to the matter in the Bulletin, although Dr. Leonard Williams tells us that "the text of the communication was duly published and rapidly found its way into the lay press." It would be interesting to know where the full communication may be found.

M. Spahlinger's treatment is stated to be both antigenic and antitoxic, and he claims to have produced many different tuberculous toxins by a method not published. The process is a long one, and the cost of production we are told is high, involving prolonged treatment of large numbers of cattle. The only other tuberculous problem referred to by Dr. Leonard Williams is really a panegyric on the work of Calmette. We are told that the "campaign against tuberculosis will never make any serious headway until the disease is attacked at the source. That source is the tuberculous cow." This may be Dr. Leonard Williams' opinion, but it is entirely opposed to the conclusions reached by the arduous experimental efforts of a generation of accurate workers.

W. B.

Archæological History.

(1) *Die Franken und Westgoten in der Völkerwanderungszeit.* By Nils Åberg. (Arbeten utgifna med understöd af Vilhelm Ekmans Universitetsfond, Uppsala, 28.) Pp. viii + 282 + 9 kartes. (Uppsala: A.-B. Akademiska Bokhandeln; Leipzig: Otto Harrassowitz; Paris: Libr. Honoré Champion, 1922.) 15 Kr.

(2) *The Bronze Age and the Celtic World.* By Harold Peake. Pp. 201 + 14 plates. (London: Benn Bros., Ltd., 1922.) 42*s.* net.

ARCHÆOLOGICAL method has made three principal advances hitherto. Early attempts to explain similarities and diversities of form and style in human handiwork were put on a scientific basis in Germany by Klemm (whose "Allgemeine Kulturgeschichte der Menschheit" appeared in 1843) and were re-interpreted on Darwinian lines by Pitt Rivers's "Principles of Classification" published in 1874; Kapp's "Grundlinien einer Philosophie der Technik," Semper's "Der Stil," and Hoernes' "Urgeschichte der Kunst" marking later refinements of this morphological criticism. Stratigraphical corroboration of evolutionary sequences thus indicated begins with examination of the Swiss lake-dwellings by Keller, Troyon, and others, the word *Kulturschicht* first appearing in an excavation report of 1855. The spade-work of Ramsauer at Hallstatt from 1862, of Warren and Wilson at Jerusalem from 1867, and of Schliemann at Troy from 1871, are notable early dissections of long-inhabited ground; and the developed technique of this kind of stratigraphy may be studied in Petrie's "Methods and Aims in Archæology."

The two books now under review approach archæological problems from yet another point of view. Even casual finds are at all events found *somewhere*. They can be plotted on a map; and when these plottings are sufficiently numerous, and their geographical distribution begins to be apparent, regions of occupation by this or that phase of culture may be defined, and the spread or shrinkage may be inferred of the people who practised each kind of handiwork which the finds reveal, and felt the needs which the craftsmen of each generation were there to satisfy. Thus, as Rostovtseff says of his own study of "Iranians and Greeks in South Russia" (Oxford, 1922), "we are gradually learning how to write history with the help of archæology." The method is precisely that of the staff-officer who establishes an enemy's order of battle from cap-badges and scraps of local newspaper, and estimates its artillery value from the splinters of his shells; and the value of archæological training was demonstrated on every front in the recent war.

Obviously this kind of antiquarian geography has had to wait until the finds themselves were sufficiently numerous; until they had been sufficiently announced, in museum catalogues and publications in detail; still more, until geographers (and, let us add, geologists) had accustomed their archæological colleagues to regard their proper "fossils" from the new point of view, looking not only "to the hole of the pit whence they were digged" but also "to the rock whence they were hewn."

(1) Dr. Åberg's work on the stone age culture of northern Europe, and on the first age of metal in the Iberian peninsula, is sufficient guarantee for scientific scholarship of the first order; his book on "East Prussia in the Migration Period" is an original contribution to one of the darkest phases of European history; and his present monograph on the "Franks and Visigoths in the Migration Period" is of the same fine quality. Naturally, his treatment of the material varies. Visigothic handiwork must be won by travel and research in local museums and private collections, and we are here still among the pioneers. But Frankish antiquities have been copiously published and studied, and the casual finds have been supplemented by systematic investigation of whole burial grounds, so that "sequence-dating" supplements the comparison and affiliation of types, and facilitates interpretation of regional surveys. As most of the work has been done hitherto by French archæologists, and from the point of view of the invaded regions, the principal need was now to look at the whole matter from the other side. As Rostovtseff puts it, in a parallel case, "I do not regard South Russia as one of the provinces of the Greek world . . ." but "as always an Oriental land," so Dr. Åberg might say that he does not regard the Franks as one of the peoples who intruded upon Gallo-Roman civilisation, but as always a Teutonic people. The result is an interpretation not only of the Frankish finds of the west, but also of all the congruous material east of the Rhine, north of the Alps, and so far afield as Hungary and Scandinavia, and also in Lombardy and beyond, as contributions to the narrative of a progressive Frankification (so to speak) of indigenous Teutonic culture through the instrumentality of those peoples of Teuton origin who had most completely appropriated the west-land civilisation which they mastered politically.

Thus, in a sense which will be a revelation to many, *Gallia victa victorum cepit*: or as Dr. Åberg puts it (p. 15), "the Franks in Gaul were influenced indeed, like the Goths in Italy, by Roman culture, but in contrast with them, they retained their power in spite of their loss of Teutonic quality, thanks to the maintenance of intercourse along the lines of communication with the heart of Germany. Consequently there was no gulf here between Germanic and Roman, but a gradual transition. Roman organisation pressed slowly eastward. . . . The focus of development, which in Merovingian times had been mainly Gaul, shifted over in Carolingian times on to German soil. Here came about the last amalgamation of Roman and Germanic which is the foundation of modern Europe. Only Scandinavia still stayed long outside this development, as a last remnant of ancient Germany, and a wound in the side of Europe which was hard to heal."

For the stages of this revolution in social and political structure Dr. Åberg offers us as testimony not edicts or charters, nor a *cursus honorum* such as has revealed the spirit and the structure of imperial Rome, but the mute eloquence of hundreds of brooches and buckles, of ingenious design, intricate ornamentation, and accurately plotted distribution. His inventory of type-specimens occupies 42 pages, and his nine maps of the principal phases which he has been able to distinguish are models of this kind of interpretation. His first two chapters, occupying only forty pages, trace the outlines of the whole inquiry, and summarise the course of events before the opening of the fifth century, at which his proper study begins. These and the subsequent later review of Merovingian influence east of the Rhine are what will chiefly interest the historian; the remainder of the book, with its ample and well-executed illustrations, concerns rather the student of design and of the transference of decorative motives from one repertoire to another.

The account of the Visigothic occupation of Spain and Portugal (pp. 206-240) is more tentative, because (as already noted) the material is scanty and inaccessible, and, to judge from the specimens which are figured here, less instructive as to the movements of Germanic peoples in this region. Provisionally, Dr. Åberg groups all Germanic antiquities from this area as "Gothic," reserving till a later stage the possibility of assigning some types to particular peoples.

A word should be added to congratulate the Vilhelm Ekmans Fund at Uppsala on having produced so learned, valuable, and well-appointed a volume at the rate of less than three farthings per page.

(2) Mr. Peake's book is of a different quality. Spaciously printed, and well bound—and we must add, more than adequately priced at 2½d. per page—it is little more than a reprint of a course of six University lectures, with acknowledgments of the principal sources of printed information, the bare minimum of outline diagrams, and far less than the due minimum of distribution maps. The author disarms criticism when he declares his purpose to be "not so much to record evidence as to interpret it, to restore the main features of early history than to describe archæological remains." It is, in fact, an essay rather than a formal treatise. It covers very wide ground, from a preliminary survey of the pre-Celtic continent—Nordic, Alpine, and mixed Mediterranean stocks, partially brought into economic relations by slow breach of natural barriers, especially forest and mountain, and by the pervasive wiles of the "prospectors"—to the problem of the replacement of bronze by iron for cutting-weapons, and the superposition of "P-Celts" upon "Q-Celts" and of other P's upon other Q's.

To be proficient at all points of such a programme would be a giant's task. Mr. Peake has read widely (though scarcely widely enough) and has thought independently and boldly; and his book is always readable and intelligible. Frequently his suggestions carry conviction; his mistakes are mostly of omission; and his summaries even of the most controversial matters are discreet and fair. Obsolete learning he is for the most part content to leave on one side, and where he feels obliged to review the course of inquiry, as in the chapter on the "Aryan Home," he knows how to select main turning-points, and distinguish the permanently suggestive idea from the transitory prejudices which advertised or obscured it at its inception.

The problem which Mr. Peake has set before himself is to compare the archæological evidence for reputed movements of peoples within peninsular Europe, from the end of the third thousand years B.C. to the beginning of the first, with the philological conclusions on the same subject derived from the relationships and distributions of languages. His conclusion, briefly stated, is that the distribution over Europe and its neighbourhood, of the series of types of so-called "leaf-shaped swords" of bronze, is such as to indicate successive eruptions of peoples armed with these swords, from the Hungarian plain into various adjacent regions and beyond them. Also that the disappearance of the later types of the series from Hungary itself and from surrounding districts may be so closely associated with the distribution of other swords, similar but derivative and made of iron, as to justify the inference that it was the aggression of the men of the iron swords that determined the retreat or disappearance of the users of "leaf-shaped" bronze blades. Lucky finds of typical swords in datable surroundings, and especially the discovery in Egypt of a sword of European type, about half-way down the morphological series, engraved with the name of King Seti II., who reigned only from 1209 to 1204 B.C., enable him to reckon the probable duration of the whole series of events, and to institute a very suggestive comparison of them with the movements of the two main groups of Celtic-speaking peoples, from much the same area of origin around the middle Danube, into Western Europe and Britain, and of similar waves of "P-using" and "Q-using" immigrants into peninsular Italy, and probably also into Greece; though Mr. Peake is discreetly reserved in his treatment of these last.

Much of Mr. Peake's material is, of course, familiar; it is his courageous attempt to compare disparate series, and draw historical conclusions, which justifies his book; and it will be found full of suggestive passages, even by those who will best appreciate the difficulties of his task and the defects of his equipment for it. It is eminently a book to be judged by its merits, not by its faults. It has omissions, but its main argument is clear and generally coherent; it has slips and some misapprehensions in detail, but they do not seriously detract from its cogency. Its central contribution to learning, the establishment of a morphological sequence among the "leaf-shaped swords" by comparative study, not of their blades but of their hilts, is of considerable importance. This is a kind of work of which much more remains to be done: a similar essay on the fibulæ alone would probably lead to appreciable revision of the conclusions of Montelius and his contemporaries a generation ago, and would be the only conclusive test of the validity of Mr. Peake's inferences. It must also be noted here that even what has been attempted in this essay is but the first-fruits of the great inventory of the types of prehistoric implements, so long overdue, of which only the British section of the bronze implements has been systematically attempted as yet, by Mr. Peake himself and a British Association committee. Till such an inventory has been very greatly extended, and the distributions which it alone can reveal have been plotted and compared, prehistoric archæology can scarcely be said to have entered upon a truly scientific phase. It is one of the merits of any piece of work such as this essay, that it illustrates by example, even if also in some degree by anticipation, the value of such an addition to archæological equipment as the British Association's inventory is already proving itself to be.

Gelatin and Glue.

The Chemistry and Technology of Gelatin and Glue. By Dr. R. H. Bogue. (Mellon Institute Technochemical Series.) Pp. xi+644. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 30*s*.

ANYONE who, in recent years, has had occasion to deal with the question of gelatin has been confronted at the outset with the fact that no adequate summary of the existing knowledge was available. An immense amount of information was widely scattered in the various scientific and technical journals of all countries, but it was so varied in character, and very often so contradictory, that the task of making a summary which was something other than a mass of apparently disconnected facts seemed almost hopeless. The pioneering work of Procter in England, which dealt chiefly with gelatin, and of Pauli in Austria, which was concerned with proteins in general, gave the first indication of the basis on which such a summary could be made; but the more recent work of Loeb in America has perhaps helped more than anything else towards a clarification of ideas. The work of Brailsford Robertson should also be mentioned, since he has collected a large amount of experimental data, although his theoretical conclusions are accepted by few.

The clarification of ideas has been chiefly confined to the physico-chemical treatment of the subject. The more purely chemical aspect of the question has not advanced much beyond the identification of the break-down products of gelatin, and the more or less satisfactory methods of estimating the percentages of the various kinds of combined nitrogen.

During the last few years American scientific journals especially have obtained a large number of papers on gelatin, which have been published by workers other than Loeb. Among the chief of these workers has been Dr. Bogue, and it is therefore not to be wondered at that, of three books on gelatin which have been announced in the American press for some time past, his is the first to be published. Dr. Bogue is research chemist for Armour and Company of Chicago—would that English gelatin firms were as wide awake in this respect as the American ones!—and is consequently in touch with the technological as well as with the more purely theoretical side of the subject. His book has therefore been awaited with interest by those who have to deal with gelatin, and they will not be disappointed, since the author has been eminently successful in correlating and summarising the enormous amount of material at his disposal, and in giving a clear and readable account of the subject. After an introduction dealing with historical and statistical considerations, the theoretical aspects of the subject are considered. These include the constitution of the proteins, the chemistry of gelatin and its congeners, the physico-chemical properties and structure of gelatin, gelatin as a lyophile and as an amphoteric colloid.

The author seems to have contented himself with giving only such literature references as are necessary for drawing up a connected account of the subject.

This was probably a wise course to adopt, since otherwise the book would have become very unwieldy, but it has meant that a number of important papers published in German journals are not mentioned. For example, Dr. Bogue is a great advocate of the fibrillar structure of gels, but no mention is made of similar views put forward by Moeller in a number of different papers in the *Kolloid Zeitschrift*. A lucid description is given of the various physico-chemical properties of gelatins and glues and the various theories are dealt with in detail. If anything, the author has not been sufficiently critical in describing the theories of Brailsford Robertson, who assumes a peculiar kind of dissociation which appeals neither to the organic nor to the physical chemist, and against which there is a mass of evidence accumulated by Pauli, Loeb, and others. Actually, Dr. Bogue attempts to modify Robertson's theory, so as to make it more in accordance with the work of Loeb, but the modified theory is still open to most of the objections raised against the original theory.

The second part of the book deals with the technological aspects of the manufacture, testing, chemical analysis, evaluation, uses and applications of gelatin and glue. The point of view taken is that of the chemist rather than that of the plant technologist, and this makes the appeal of the book all the greater to the student and investigator. In the chapter on the uses and applications of glue there is a section on glue-room economy and technology, which may be recommended for study to all users of glue on a large scale, so that increased efficacy, based on the application of scientific principles, may be attained in their workshops.

There is also a special chapter on water-resistant glues and glues of marine origin, which should be read in conjunction with the first report of the Adhesives Research Committee. An appendix deals more especially with the electrometric and indicator methods of determining hydrion concentrations.

Generally speaking, there is little which calls for criticism, except the curious statement made on p. 221 that acetic acid is an amphoteric substance because the hydrogen of its carboxyl group may be substituted by metals and the hydroxyl by chlorine (by the use of phosphorus trichloride). A few misprints, such as "existance" and "catinary," have been noticed, and the following statement on p. 141 requires revision: "but this does not follow for a continuous membrane that was semipermeable in the sense of being able to dissolve the solvent or medium of dispersion would likewise behave as an ultra-filter." Also, why should it be necessary to write "Anfangsdekrement" instead of "initial decrement"?

T. S. P.

Flora of New Zealand.

Die Vegetation der Erde. Sammlung pflanzengeographischer Monographien. Herausgegeben von Prof. A. Engler und Prof. O. Drude. XIV. *The Vegetation of New Zealand.* By Dr. L. Cockayne. Pp. xxiii + 364 + 2 maps + 65 plates. (Leipzig: W. Engelmann; New York: G. E. Stechert and Co., 1921.)

WITH the landing of Sir Joseph Banks and Dr. Solander at Poverty Bay on October 8, 1769, our knowledge of the flora of New Zealand commenced, but unfortunately the results of the labours of these two intrepid explorers have never been published, though the plates of the new plants were prepared at Banks's expense and the descriptions were drawn up by Solander. From this time onwards various expeditions, both English and French, reached New Zealand, making small collections, the results of which were published, but Sir Joseph Hooker's first volume of his "Flora Antarctica," published in 1847, must be regarded as the first comprehensive flora of these islands. As a result of the help received from many collectors, Hooker published his "Flora Novae Zelandiae" (1853–55), which truly marked a new era in the botany of New Zealand, but still little was known of the South Island alpine flora, and it is to Travers, Haast, Hector, and Buchanan that we owe a great deal of our knowledge of the flora of this region.

Sir Joseph Hooker again contributed to our knowledge of the flora in his "Handbook of the New Zealand Flora" (1864–67), undertaken at the instance of the Government of New Zealand, and since then the task has been fittingly and very ably taken up by New Zealand botanists, among whom must especially be mentioned T. Kirk, T. F. Cheeseman, D. Petrie, and L. Cockayne, the author of the valuable work under notice. Dr. Cockayne commenced his botanical work in 1887, and has continued his explorations with great assiduity and keen insight ever since. Becoming gradually more interested in ecology, the present volume, dealing with the vegetation of New Zealand in its many aspects and in relation to the varied plant associations, could not have been entrusted to more worthy hands. Nor could the subject have been more ably treated.

In an introductory chapter the history of our knowledge of the flora is detailed and the book is then divided up into four parts. The first part, as is proper in a treatise planned on ecological lines, deals with the physical geography and climate of the three main islands and of the outlying groups, the chapter on the climate and rainfall being contributed by Mr. D. C. Bates. It is unfortunate that the maps are sadly deficient in the way of names and orographical details, both of which are essential for a proper appreciation of the work. Possibly the difficulty of publication so soon after the War, and also in Germany, may account for this blemish to a book which is remarkable in the excellence of its form and style, considering that author and publisher were at opposite sides of the world.

The second part naturally occupies the greater portion of the book, since it deals with the various formations or plant associations, and full details and excellent illustrations are given of the leading physiognomic plants and their growth forms. In the first section the sea-coast vegetation with the characteristic dune plants, salt meadow and coastal scrub, Olearia and Veronica associations, are described, and this leads to a discussion of the plant formations of the lowlands and lower hills, characterised by many peculiar endemic New Zealand plants. Among these the "Southern Beech" forests, comprised mainly of the different species of Nothofagus, are of great interest. Passing upwards through the grasslands or steppe, where the "Tussock" (Poa, Festuca, and Danthonia) associations flourish, the author naturally follows with an account of the vegetation of the high mountains. This is remarkable in that no less than 498 species of vascular plants are entirely confined to the mountains, but since many lowland plants are also found at high elevations, the alpine flora is found to number 945 species. Of these no less than 561 are endemic.

In Part III. the relationships of the New Zealand flora are fully dealt with, but it may be mentioned here that of this flora about 35 species belonging to as many genera have near relatives in subantarctic South America.

The vegetation of the outlying islands is then fully dealt with on the same lines as that of the main islands, and, in the subantarctic islands, it is shown that there are some 55 endemic, 123 New Zealand, and 32 subantarctic South American plants, nine of which are not found on the main islands of New Zealand.

The fifth section of this second part deals with the effect of "settlement" upon the plant covering of New Zealand and is by no means pleasant reading. The hand of man, his introduced animals and plants, have, in New Zealand as elsewhere, wrought irreparable destruction and modifications in the primeval and singular plant covering.

In the final part, Dr. Cockayne gives a brief but useful history of the flora from the Jurassic period to the present time, and lays stress on the subantarctic affinities both of the flora and fauna of New Zealand. Whether land connexions with an antarctic continent ever existed, or chains of islands linking the southern continents provided the bridge which enabled species to migrate to what is now S. America on one hand and Tasmania on the other, must ever remain a problem. Dr. Cockayne considers that the difficulty of transoceanic transit is too great to account for the affinities, and, no doubt rightly, inclines to the problematical bridge of land or islands in the dim past. Whatever may have been the origin of this interesting primeval flora, it is very satisfactory to note that the Government of New Zealand is taking all possible steps to preserve, so far as may be possible, its unique features.

Electrical Engineering.

Standard Handbook for Electrical Engineers. Prepared by a Staff of Specialists; Editor-in-Chief: Frank F. Fowle. Fifth edition, thoroughly revised. Pp. xviii + 2137. (New York and London: McGraw-Hill Book Co. Inc., 1922.) 30*s*.

WE think that the volume under notice justifies its title as being a "standard" handbook. The general make-up and arrangement leave little to be desired. The whole field of electrical engineering is divided into twenty-five sections each complete in itself; these are all numbered and by special depressions on the edges of the pages any particular section is found at once. The index is good, the references being made to section and paragraph. The sections have all been written by well-known American engineers and physicists and have been brought carefully up to date; for example, the section on units is written by Kennelly, magnetic circuits by Karapetoff, illumination by Millar, and electric ship propulsion by Hobart.

We were momentarily surprised to learn from Prof. Kennelly that the M.T.S. (metre-ton-second) and the Q.E.S. (quadrant-eleventh-gram-second) systems had come into extensive use. This latter system, however, is only the international electromagnetic system used in electrical engineering. We were glad to see it definitely stated that the electric and magnetic constants of the ether should not be taken as pure numerics. The section on power transmission is very thorough and data are given which would be very difficult to find elsewhere. The twenty-fourth section gives the 1921 edition of the standards of the American Institute of Electrical Engineers. In connexion with the distortion of waves, we are sorry to see that they still call a certain very variable ratio the "deviation factor" of the wave. In defining the distortion of a wave it is necessary to take into account the phase differences as well as the magnitudes of the amplitudes of its harmonics. We notice also that a resistance coil, a choking coil, and an inductive coil are now called a resistor, an inductor, and a reactor.

The final section is on general engineering economics and will be of great interest to commercial engineers. It is stated that "profits" represent a return on the capital over and above the normal rate of interest. For example, if the difference between income and expenditure was 10 per cent. then assuming that 6 per cent. is the normal rate of interest on investments, the "profit" would be 4 per cent. Apparently in America there is no agreed theory of depreciation, the straight-line or simple interest method and the sinking-fund or compound interest method are both still used.

The references given include the best American and English authorities and are useful ones. We can heartily recommend the book. A. R.

Our Bookshelf.

The Yearbook of the Universities of the Empire, 1923. Edited by W. H. Dawson. (Published for the Universities Bureau of the British Empire.) Pp. xii+692. (London: G. Bell and Sons, Ltd., 1923.) 7*s.* 6*d.* net.

The latest edition of the Yearbook, revised and amplified, should be of the greatest help not only to those officially concerned in university administration, but also to all who are interested in the developments within the British Empire of higher and professional education. It is no small feat to compress within the cover of an easily handled (and well indexed) volume the essential details of the calendars of the sixty-six universities of the Empire. Mr. Dawson, who has edited the book for the Universities Bureau, has accomplished the task very creditably, and the abbreviations and other typographical devices to which he has had recourse do not in any way militate against intelligibility, and, so far as we have tested it, the information given is both accurate and adequate.

The appendices, which now run to more than 150 pages, contain some interesting information, not easily accessible elsewhere, regarding admission to the various professions and the qualifications necessary. A section on foreign universities gives some brief but useful particulars of the principal universities on the continent and also of the universities of the United States, including a list of the institutions approved by the Association of American Universities.

Mention should also be made of the information relating to the admission to universities in the United Kingdom of persons educated abroad, to scholarships and grants for research, and to the distribution of subjects of study among British universities. Particularly interesting is a table showing the numbers of students from overseas, which suggests that the resources of this country for postgraduate and other study are now being appreciated. The total number of such students is more than 4000. At London University alone there are 81 from Egypt, 336 from South Africa, 46 from Canada, 72 from the United States, and 335 from India.

The Microscopical Examination of Foods and Drugs. By Prof. H. G. Greenish. Third edition. Pp. xx+386. (London: J. and A. Churchill, 1923.) 18*s.* net.

Prof. Greenish's volume stands alone as a modern English text-book of the subject, and it is a matter of considerable satisfaction that author and publisher combine to keep the work abreast of the times. In the new edition, the text has been carefully revised and brought up-to-date, but we are informed that the inclusion of additional matter has not been possible on account of the prevailing high costs of paper and printing. We hope that by the time a further edition is called for, a means will have been found to overcome this difficulty, if it should still exist.

The book is too well known to need detailed description, but for the benefit of new students and others we may mention that its special value lies in the fact that it furnishes detailed information regarding methods of investigation which have been developed during many years by an acknowledged expert in the subject. In work of this kind, prolonged and continuous experience is a *sine qua non* for accurate determinations, and the methods so fully and clearly set out in this handbook bear unmistakable evidence of such experience. The book is essential to all pharmacological laboratories and students, and we suggest that teachers of "pure" botany would find many hints as to methods and material which would be of assistance to them in obtaining fresh ideas for the scheme of practical work to accompany their histological lectures. If in a later edition it is decided to retain "silk" as a material for description, we suggest that space should be found for a somewhat fuller treatment of the subject, including a reference to the important results obtained by von Höhnel in his investigations of the different kinds of commercial silks.

The Analysis of Non-Ferrous Alloys. By Fred Ibbotson and Leslie Aitchison. Second edition. Pp. ix+246. (London: Longmans, Green and Co., 1922.) 12*s.* 6*d.* net.

The fact that a second edition of this text-book has been called for is evidence that it has been found useful by analysts. War experience has led to an enlargement of the field of non-ferrous alloys, and the authors have therefore added to the matter of the former edition an account of the analysis of alloys containing aluminium as their principal constituent, and also of those rich in nickel, such as cupro-nickel and nichrome. The light aluminium alloys form a particularly difficult class, and it has been found necessary to devote a special chapter to the separation of zinc and aluminium, the authors recommending the precipitation of zinc sulphide from alkaline solution or the electro-deposition of zinc. The otherwise excellent section on electrolytic analysis suggests that no cathodes other than platinum and mercury can be used successfully, but many laboratories now employ copper and nickel gauze cathodes with entire success; an important consideration when the cost of platinum is so high.

The subject of hydrogen sulphide precipitations is dealt with thoroughly, this being a matter on which it is most important to have a clear view of the conditions affecting precipitation. The newer organic reagents, such as cupferron, are not described.

The work may be thoroughly recommended to professional analysts as well as to students, the authors having a wide personal experience of the methods they describe, their views on the best methods of analysing difficult alloys being particularly valuable.

La Radiotéléphonie. Par Carlo Toché. Pp. vi+98. (Paris: Gauthier-Villars et Cie, 1922.) 10 francs.

The book under notice gives an interesting general description of the best and most modern methods of radiotelephony. It presupposes on the part of the reader an elementary knowledge of the subject and a general knowledge of science. It begins by describing the physiology of the voice, giving photographic records of voice vibrations obtained by Marage. It is interesting to note that oscillograms obtained of microphonic currents produced by speech are not so simple as those shown. The arc, alternator and valve methods of radiotelephony are next described, more stress being laid on the theory than on the history of the art. Due credit is assigned to the work done by the American Western Electric Co. A good discussion is given of the possibility of simultaneous communications in radiotelephony. The essential frequencies required for speech vary between 200 and 2000 per second, and the frequency of the carrier waves between 15,000 and three million per second. The author concludes that the maximum possible number of simultaneous communications is 1492. It has to be remembered that many of these waves have short wave-lengths and are therefore not suitable for long-distance transmission. For international and intercontinental systems the possible number would be much smaller. The number of possible radio-telegraphic systems with carrier waves is very much larger than the number of possible telephonic systems.

The Grammar of the Lamba Language. By C. M. Doke. (Published under the Joint Auspices of the University of the Witwatersrand, and the Council of Education, Witwatersrand.) Pp. ix+157. (London: Kegan Paul and Co., Ltd., 1922.) 6*s*. net.

It is a pleasure to extend a welcome to this scholarly study of the Lamba language, not least on the ground that it is published under the auspices of the Witwatersrand University and Council of Education, and bears witness to the official interest now taken in native studies.

The Lamba language is spoken throughout the Ndola district of North-Western Rhodesia and in the south of the Katanga, this area lying in the centre of Bantu Africa. It is claimed to be the most primitive dialect of Bantu now extant, a view to which the author inclines on the ground of its strict adherence to rule and the great simplicity of its phonetics. Numeration is based upon the quinary system. The use of onomatopœia is very prevalent, and not only can all verbs be reduced to a monosyllable root, but they also appear to have evolved from onomatopœic sounds, adjectives and nouns representing a further stage in evolution. Lamba contains a number of loan words from Portuguese (the earliest), Swahili, English, and Dutch, as well as from other Bantu dialects. The days of the week, it is interesting to note, are taken from Chinyanja.

A Manual of Practical Anatomy: A Guide to the Dissection of the Human Body. By Prof. Thomas Walmsley. In 3 parts. Part 3: The Head and Neck. Pp. viii+272. (London: Longmans, Green and Co., 1922.) 10*s*. 6*d*. net.

The third part of Professor Walmsley's "Manual of Practical Anatomy" is devoted to the dissection of the head and neck, for which a period of about ten weeks is suggested. The usual order of dissection is adopted, the various regions and organs being treated separately, but without that strict confinement to region which is so confusing to the student when dealing with a structure which appears in different portions of the dissection. The instructions for the guidance of the dissector are clearly given; the anatomical descriptions are complete and well illustrated by diagrams which the student is encouraged to label from his own specimen. The only defect in the book is that the index is not very complete. We are glad to observe that the nomenclature is in the British (Old) terminology. The book can be thoroughly recommended as a guide to the student in the dissecting-room.

Inorganic Chemistry: A Text-book for Schools. By E. J. Holmyard. Pp. x+560. (London: Edward Arnold and Co., 1922.) 6*s*. 6*d*.

Mr. Holmyard has written what is really an excellent text-book for schools. The style is clear and the arrangement on the whole good, although the very late appearance of the halogen elements is perhaps not quite fair to their great activity and their participation in the lives of the other simple bodies. The historical notices, as might have been expected, are excellent, and they and a number of portraits of famous chemists add considerably to the interest of the book. We wish this book the full success it deserves.

The Handbook of Palestine. Edited by Harry Charles Luke and Edward Keith-Roach. (Issued under the authority of the Government of Palestine.) Pp. xii+295. (London: Macmillan and Co., Ltd., 1922.) 12*s*. net.

This is mainly a handbook of general information, but there are short chapters on the geology and natural history and a note on the flora. Forestry receives more attention. Meteorology is scarcely noticed. The sections on races and on archæology are fairly full. A folding sketch-map shows roads, railways and archæological features, but no relief. The handbook should prove of value to every visitor to Palestine, but it might be given a wider and more permanent value if the historical and scientific sections were extended.

The Radio Year Book, 1923 (First Year). Pp. viii+148. (London: Sir Isaac Pitman and Sons, Ltd., 1923.) 1*s*. 6*d*. net.

It is intended to make this the Year Book of the new industry which is rapidly growing, owing to the great popular interest which is being taken in broadcasting. Section I. gives general information of use to radio amateurs. Section II. gives short and trustworthy articles on subjects of general interest in the working of radio apparatus, and Section III. gives information which will be useful to manufacturers and suppliers of the apparatus. The articles are by well-known experts, and the book should prove useful.

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.*]

On Urbain's Celtium Lines.

In a previous letter (NATURE, March 10, p. 322) we have shown that the optical spectrum of the new element hafnium, of atomic number 72, which was discovered a short time ago by Coster and Hevesy, does not contain any of the lines belonging to the characteristic spectrum ascribed by Urbain (*Comptes rendus*, t. 152, 1911, p. 141) to an element celtium belonging to the family of rare earths, which element was assumed by Dauvillier and Urbain (*Comptes rendus*, t. 174, 1922, pp. 1347 and 1349; NATURE, February 17, 1923, p. 218) to possess the atomic number 72.

Through an examination of the very careful measurements of the spectra of the rare earths published during the last few years by Eder, we have learned in the meantime that the greater part of Urbain's celtium lines have been observed by this author (*Wiener Ber.*, IIa, vol. 124, 1915) in the spectrum of a preparation of the rare earth element cassiopeium or lutetium. The discovery of this element (atomic number 71) was announced in 1905 by Auer von Welsbach, to whom the former name is due, while the name lutetium was proposed in 1907 by Urbain, who published at the same time the first list of lines of its optical spectrum (*Comptes rendus*, t. 145, 1907, p. 759).

In the table below we give the wave-lengths of the celtium lines from Urbain's paper, together with their relative intensities (by use of the numbers 2, 4, 6, and 8 instead of Urbain's notations: *moyenne*, *assez forte*, *forte*, *très forte*) and the corresponding wave-lengths and intensities from Eder's measurements of the cassiopeium spectrum, corrected to Rowland's scale.

Urbain's Ct Lines.		Cp Lines observed by Eder.		Urbain's Ct Lines.		Cp Lines observed by Eder.	
2459·4	2	2459·71	1	2885·1	4	2885·23	3
2469·3	2	..		2903·9	4	..	
2481·6	4	2481·79	2	2931·7	2	2931·56	1
2536·9	4	2537·09	2	2949·5	4	2949·82	3
2677·7	2	2677·35	1	3080·7	8	3080·22* 3081·59	4 8
2685·2	8	2685·24	3	3118·6	8	3118·56*	5
2729·1	6	2729·08	3	3171·4	6	3171·49*	5
2737·9	2	..		3197·9	8	3198·25*	8
2765·8	8	2765·88	3	3326·0	4	..	
2834·3	4	2834·37	1	3391·5	6	3391·73	4
2837·3	4	..		3665·6	2	..	
2845·2	6	2845·23	2				
2870·2	2	..					

It is important to notice the very close accordance in the values of the relative intensities in the two tables, which we think justifies the identification of the lines also in the few cases where the difference between the wave-lengths is slightly greater than is to be expected from the usual accuracy of Urbain's measurements of wave-lengths of rare earths. Only a few of these lines, denoted by an asterisk, were included in Urbain's original list of the lutetium lines.

In order to verify the origin of Eder's lines and to endeavour to find out why most of these lines were not included in Urbain's original list, we have examined the optical spectrum of a highly purified cassiopeium preparation kindly presented to this institute by Dr. Auer von Welsbach. At the same time Dr. Coster has photographed the X-ray spectrum of the same preparation and found it to contain no trace of an element with atomic number 72. Our exposures revealed in the spectral region investigated (2500-3500 Å) all the lines observed by Eder and brought certain new features to light, which made it possible to understand why these lines were not observed in the original investigation of the lutetium spectrum published by Urbain in 1907. In an exposure in which the salt was placed at the carbon anode of the arc, the celtium lines came out sharp and in about the same relative intensities as in Eder's investigations, but when the salt was placed at the cathode, most of the celtium lines were much more intense and very diffuse and broad, especially in the part of the arc nearest to the cathode. The only celtium lines which also under these conditions came out as sharp as the rest of Eder's cassiopeium lines were the four previously mentioned lines denoted in the table by an asterisk. On account of this behaviour of most of the celtium lines they will be very difficult to observe in less pure preparations. Some exposures taken with a less concentrated (10 per cent.) sample, formed by mixing Auer's preparation with a scandium salt, did in fact show only the usual lines, whereas most of the celtium lines could be detected only by the presence of an increase of the continuous background of the plate. Urbain's results are therefore easy to understand, if we assume that the preparations investigated by Urbain in 1907 contained a comparatively small amount of the element with atomic number 71, and that only after treating the preparations further a concentration was obtained sufficient for the production of the diffuse lines, which in 1911 were ascribed to the presence of a new rare earth element, which was called celtium.

As to the origin of the lines given by Urbain as celtium lines, and not present in Eder's cassiopeium spectrum, we have found in the spectrum of Auer's preparation a weak line with wave-length 2738·1 Å, which may be identified with a celtium line (2737·9 Å). The line 3326·0 occurs as a weak line in the mentioned mixture of scandium and cassiopeium, but could not be found in the spectrum of Auer's pure preparation. As Urbain states that scandium was present as an impurity in his preparations, and as the scandium spectrum is not very well known, we have also taken a strong exposure of this spectrum, but could not find any of the remaining lines. Probably these lines have the same origin as the other celtium lines, but as they are weaker they will need a very strong exposure, especially if they also are diffuse. For such strong exposures we had not sufficient material.

It is of interest to add that in a recent note (*Comptes rendus*, t. 176, 1923, p. 496), which first came to our notice after the above was written, dealing with the discovery by Coster and Hevesy of the element hafnium with atomic number 72, Urbain himself directs attention to the particular behaviour of the lines ascribed by him to celtium, and expresses the conjecture that these lines—the observation of which was the basis for his belief in the presence of a new element in his preparation—may actually constitute the spark spectrum of the element 71.

H. M. Hansen.
S. Werner.

Universitetets Institut for teoretisk Fysik,
Copenhagen, March 20.

On Celtium and Hafnium.

In our letter of February 9, which appeared in Nature of February 24, p. 252, we have shown that the element hafnium, of atomic number 72, detected by us in zirconium minerals, possesses physical and chemical properties quite different from those ascribed to a rare earth element celtium, the discovery of which was announced by Urbain in 1911, and which recently was believed by Dauvillier and Urbain also to possess the atomic number 72. In a communication of February 19 to the Paris Academy of Sciences (*Comptes rendus*, vol. 176, p. 496, 1923) Urbain discusses the same problem and still claims the identity of his celtium with our hafnium and by a claim of priority rejects the latter name. In the meantime, through the investigation of Hansen and Werner (see Nature of March 10, p. 322, and the above letter in this issue) on the optical spectrum of hafnium and on the spectrum ascribed by Urbain to celtium, new data have been brought to light, and we should therefore be glad to take the opportunity to complete our arguments as regards the questions discussed by Urbain.

To put the matter clearly we must go back to the time preceding the announcement of the discovery of celtium. As is well known, Marignac succeeded in 1878 in isolating from a mineral from Ytterby a substance which was considered to be a new element and called ytterbium. In 1905 Auer von Welsbach (*Wiener Anzeiger*, x., 1905; see also *Sitzungsberichte* 115, July 1906, and *Lieb. Ann.* 351, p. 464, 1907) announced the discovery that this substance was a mixture of two elements, for which he later proposed the names aldebaranium and cassiopeium. Detailed information with regard to the spectra of these elements and their atomic weights was first published by him in 1907 (*Wiener Sitzungsberichte*, 116, December 1907), shortly after a similar announcement had been made by Urbain (*Comptes rendus*, 145, p. 759, 1907), who was the first to publish lists of lines for the separate spectra of the two new elements, and proposed the names neo-ytterbium and lutetium. By continued purification of his preparations, Urbain observed in the following years a gradual change in the spectrum and magnetic properties and announced in 1911 (*Comptes rendus*, 152, p. 141) the detection of a further element, which was called celtium, for which a separate list of spectral lines was published.

Through the work of Hansen and Werner referred to above, it is clear, however, that the latter lines are due not to a new element but to the element which was called lutetium by Urbain and cassiopeium by Auer von Welsbach, in the spectrum of preparations of which the same lines were also observed by Eder in 1915. To this we may add that the same view is supported in a striking way by investigations on the magnetic properties of the various preparations. The circumstance that the paramagnetism of Urbain's preparations of 1911 was three or four times smaller than that of his former preparations need not be explained as due to the presence of a new element, but may be considered as a consequence of the gradual concentration of the element cassiopeium or lutetium in his preparations. Thus Stephan Meyer (*Wiener Sitzungsberichte*, 117, p. 955, 1908) in his investigations of the magnetic properties of the rare earths had already found in 1908 for the paramagnetism of a cassiopeium preparation a value almost as small as that measured in 1911 by Urbain for the preparation which was believed to contain the largest percentage of celtium.

In view of the conclusion drawn by Hansen and Werner as regards the optical spectrum, this circumstance may be taken as a proof that the original preparations of Urbain from 1907 (*Comptes rendus*, 145, p. 759) contained only a rather small fraction of the element cassiopeium or lutetium and presumably much less than the preparations of Auer von Welsbach of the same time. In this connexion it is of interest to mention that, according to the quantum theory of atomic structure, the element of atomic number 71 must be assumed to be diamagnetic in its trivalent chemical compounds. In fact the absence of paramagnetism of such compounds is a necessary consequence of the theoretical conclusion that in the triply charged ions of the element 71 we first meet with a completed electronic configuration of four quantum orbits. (See N. Bohr, "Theory of Spectra and Atomic Constitution," pp. 106, 114, Cambridge University Press, 1922.) It was this conclusion which led to the anticipation verified by our discovery of hafnium, that the element 72 should not have properties analogous to the rare earths, but be a homologue of zirconium.

As will appear from the above, the existence of an element with the properties ascribed to celtium cannot be maintained, and we think ourselves justified in concluding that the important problem of the nature of the element 72 may be considered as settled by the discovery of hafnium and the investigation of its properties. While thus the general conclusions of Dauvillier and Urbain must be rejected, there remains the question, of secondary importance, whether the two extremely faint X-ray lines observed by Dauvillier in Urbain's preparation, which was believed to contain celtium, can have been due to a contamination of this preparation by a trace of hafnium. In the discussion of this point it must be emphasised, in the first place, that Urbain, in the course of his purification, made all possible precautions to remove elements other than the rare earths from his preparations. In fact, in his note in *Comptes rendus*, 1911, quoted above, M. Urbain states that "des impuretés de toutes sortes, provenant soit des vases, soit des réactifs, s'accumulèrent nécessairement dans des eaux mères successives. J'ai fait différents traitements de ces eaux mères par l'hydrogéne sulfuré, l'ammoniaque et l'acide oxalique, de manière à éliminer tout ce qui dans cette substance n'appartenait pas au groupe des terres rares. J'ai examiné ensuite la terre purifiée et parfaitement blanche." Now our investigations of the chemical properties of hafnium have shown that this element, just like zirconium, can be separated easily from the rare earth elements by a treatment with oxalic acid.

Only two lines of the element 72 were claimed to have been detected by Dauvillier, and even in the case of the most intense of these lines we meet with the difficulty that it falls in the same place in the spectrum as the strongest zirconium line in the second order. As an argument against ascribing this line to zirconium, Urbain states that the optical spectrum of his preparations did not show any zirconium line. An investigation of Urbain's spectrum of the "celtium" preparation, however, does not show any line of the hafnium spectrum (see Hansen and Werner, Nature, March 10, 1923) either. If the possibility of the presence of one of these elements in Urbain's preparation can be taken seriously into consideration, it should be expected that zirconium would be present in greater amount. In fact, zirconium was likely to be more abundant in the original mineral than hafnium, and a purification of rare earth preparations from zirconium and not simultaneously from hafnium, by treating with oxalic acid or any other method mentioned by Urbain, is scarcely imaginable in view of the close similarity of the chemical properties of these elements. As mentioned in our previous letters, however, the two lines ascribed by Dauvillier to the element 72 were lying 4 X-units distant from our Hf-lines, which is distinctly more than the limit of experimental error,[1] whereas the lines of the elements 70 and 71 measured by Dauvillier (*Comptes rendus*, vol. 174, p. 1347, 1922) on the same plates closely agree with the measurements of the same elements obtained by Coster (*Phil. Mag.*, vol. 44, p. 546, 1922). As the two lines according to Dauvillier were extremely faint, they may easily be explained to be of some other origin.

It is of interest to note that, at various times, announcements have been made as to the complexity of zirconium. In 1845 Svanberg claimed that in decomposing zircons he discovered a new element "norium," with a lower atomic weight than zirconium. His and Sjögren's (1853) statements were later disproved by the work of several investigators including Marignac. In 1864 Nylander reported the existence of two earths in zirconia. Five years later, by a spectroscopic investigation of zirconium, Sorby was led to announce the discovery of "jargonium" and Church of "nigrium." Finally, in 1901 Hofmann and Prandtl thought that they had found in euxenite a new element related to zirconium. It is also interesting to note that Mendeleéff, as we learn from Sir T. E. Thorpe's letter in NATURE of February 24, p. 252 (March 17), suggested that the extraordinarily discordant values for the atomic weight of titanium, found by several chemists, might be due to the presence of a homologous element of higher atomic weight in their material. Whether these statements in some cases may be explained by the presence of hafnium in the minerals and preparations under investigation, it is not easy to decide. The intricate chemistry of zirconium, and the great chemical similarity of hafnium with this element, would in fact have made any establishment of hafnium very difficult before the development of the powerful method of X-ray analysis.

D. COSTER.
G. HEVESY.

Universitetets Institut for teoretisk Fysik,
Copenhagen, March 20.

[1] Dauvillier's measurements carried out since the announcement of our discovery, on other material which possibly contained hafnium, have already led him to give new values for the same wave-lengths, which are respectively 3·4 and 2·3 X-units larger (NATURE, February 17, 1923).

Constitution of Black Maketu Sand.

THE letter of Messrs. Smithells and Goucher in NATURE of March 24, p. 397, under the above title calls for a short reply from me.

The authors do not state with what object their experiments were made, but the results of these differ so much from my own as to suggest that the sand examined by them was from another part of the deposit at Maketu, or possibly from an entirely different source, such as that on the Taranaki Coast.

Is "Prof. Bohr's conclusion that no new element is present" to be found in any paper published by him? If not, it would be interesting to know upon what authority the authors quote it.

As my original communication on this subject was made to the Chemical Society, I feel it my duty to send to the Society, in the first place, the results of my own further experiments and also those of the examination of my preparations by Drs. Coster and Hevesy. This I hope to be able to do in time for publication in the Society's Journal for April.

ALEXANDER SCOTT.

34 Upper Hamilton Terrace, London, N.W.8,
March 26.

Tracks of α-Particles in Helium.

IN a recent issue of NATURE (January 27, p. 114), Messrs. Ryan and Harkins have published some photographs of the ionisation tracks of recoiling atoms produced by collision of α-particles with air molecules. We have been also engaged in photographing the tracks of α-particles from polonium in helium, and have obtained some interesting photographs. Besides the long range recoil helium atoms, we have obtained a few photographs in which are shown the ionisation tracks of all the constituent parts of a helium atom, namely, of the nucleus and the two bound electrons. They are shown in Fig. 1 (i and ii).

FIG. 1.

It will be noticed that both the electrons are ejected on the same side of the α-particle track. One of us (D. Bose, *Zeit. f. Phys.*, 12, 207, 1922) has previously photographed the ionisation tracks of several thousands of α-particles in hydrogen, and in no case was a photograph obtained which showed simultaneously the ionisation tracks of the two constituents of a hydrogen atom. This behaviour can well be explained on the model of the normal helium atom proposed by Lande and others, according to which the two electrons move in orbits which are inclined to one another. If an α-particle strikes the atom at the moment when both the electrons are near the point where their orbits cross, then the probability of their both being ejected in the same direction is very great.

The photograph (Fig. 1, iii, *a*) presents some special points of interest. In it is shown (1) the track of the α-particle before and after collision, (2) that of a recoiling nucleus, (3) four small tracks which radiate out from the circular patch and are due to the electrons which are ejected from the atom under collision. The circular patch, which is absent in the photographs of other recoiling atoms, resolves when seen under high magnification into a number of lines radiating from a centre. An enlarged photograph which has been slightly retouched is reproduced in (iii, *b*). It will be noticed also that the path of the recoil atom is very much curved in the beginning—a phenomenon we have not observed before in the many tracks of the recoil atoms which we have obtained in air, hydrogen, and helium. Its length is 4 cm., and is larger than any of the other recoiling atom tracks which we have obtained in helium.

Judging from the number of the electrons which have been emitted we have here evidently the collision of an α-particle with an atom more complex than either hydrogen or helium; we can suppose it to be either nitrogen or oxygen; such atoms can well be expected to be present as impurities. But it is difficult to conceive how a recoiling atom of mass 14 or 16 can produce an ionisation track of 4 cm. length in a mixture of helium and water vapour, after suffering a collision with an α-particle from polonium. The distance at which the collision took place was about 3 cm. from the source. Probably the phenomena observed can best be explained on the assumption that here we have the case of the breaking up of a nitrogen nucleus by an α-particle with the expulsion of a hydrogen nucleus, which produces the long ionisation path. The cause of the large initial curvature of the path remains to be explained. It is not due to the superposition of a number of large-angled single scatterings.

Further experiments are in progress.

D. M. Bose.
S. K. Ghosh.

University College of Science, Calcutta,
February 21.

Porto Santo in Pleistocene Times.

The Geological Society of America has recently published an extremely interesting review and summary of the recent work and opinions of specialists on the Pleistocene, by Dr. H. F. Osborn and Dr. C. A. Reeds. The chronology and changes of level are fully discussed, and we are invited to consider the evidence in favour of changes in sea-level depending upon the amount of water withdrawn as ice. It is improbable that the views of Depéret, in particular, will be accepted as they stand; but it must be admitted that the glacial periods produced some world-wide changes of level, and the question how great these were becomes an extremely interesting one.

The statement of these views is an invitation to geologists all over the world to search their coasts anew, and try to detect evidence of the postulated phenomena. In the course of this search I believe few places will better repay study than Porto Santo, in the Madeira group. I have on more than one occasion directed attention to the small I. de Cima, separated from the main island by a narrow and shallow channel (Boqueirao de Cima), yet possessing a very distinct species of snail in great abundance, found nowhere else. The postulated fall of the sea in glacial times would, I think, certainly unite Cima with the main island, yet the snail has not passed. That the snail has evolved in post-glacial times seems improbable. Between Cima and the main island are some rocks, and on one of these (Sircada) Miss Nancy Paterson collected for me some fossil snails, *Ochthephila obtecta* and others. I thought at first that we had evidence of a submerged island or neck of land between Porto Santo and Cima, once supporting a snail-fauna, but now washed by the waves. Further investigation, however, convinced me that the Sircada Rock was nothing more than a large piece of the adjacent high cliff of the main island, which had fallen into the sea, carrying the fossils with it. Objection may be made that in postulating long constancy of level for the islets Cima and Baixo I do not take into account denudation, which would have worn them down had they not risen (or the sea fallen). These islets are essentially flat on the top, and wear away extremely slowly above, but rapidly along the sides, so that we have what may be called *lateral denudation*. This can be seen going on at the present time.

Continuing the investigation, we naturally ask for marine pleistocene beds. These are to be found at the Campo do Baixo, west of the Villa Baleira on the main island. A wide well has been dug at this place, and it is possible to go down and explore it fully. At a depth of about 30 feet is a layer of marine pleistocene rock, full of shells firmly cemented together. This rests on dense, dark, volcanic rock, but there is no evidence of volcanic activity in the material above. Far above the marine bed, near the surface, is dense sandy rock containing snail shells, *Plebecula bowditchiana* (Fér.), *Ochthephila tectiformis* (Sby.), etc. *P. bowditchiana* is an extinct species, but it is not certain that it lived so much later than the marine beds, for it might have been carried in shifting sand, though it is a heavy shell to travel in that manner. Another species of snail, *Ochthephila coronata* (Desh.), was found in the marine layer itself. A fine slab of the marine deposit, carrying many shells, has been presented to the British Museum. I broke up a quantity of the material, and submitted a series of the shells to Mr. J. R. le B. Tomlin, who has very kindly determined them as follows: *Erato prayensis* Rochebrune, *Mitra fusca* Swainson, *Cerithium vulgatum* Brug., *Bittium latreillei* Payr. (abundant), *Alectrion incrassata* Müll., *Trivia pulex* Sol., *Rissoa costulata* Ald., *Alvania testæ* Ar. and Magg., *A. punctura* Mont.(?), *Mangilia striolata* Sc., *Natica* sp. (? *macilenta* Phil., or perhaps *sanctæ-helenæ* Smith), *Anadema cœlatum* A. Ad. (?), *Calliostoma exasperatum* Penn., *Cardium papillosum* Poli, *C. tuberculatum* L., *Ervilia castanea* Mont., *Macrocallista chione* L. To these I may add the common *Columbella rustica* L., which was not submitted to Mr. Tomlin. A peculiar Naticoid and some others were not determined.

This is a modern fauna, many of the species still abundant in the sea near by. The place is not far from the sea, a short distance behind the line of sand hills, which are planted with tamarisk. The level of the deposit is little if at all below that of the shore, and we are not obliged to postulate anything more than a deeper bay, now largely filled up with sand.

This brief discussion merely opens up the subject, and it is to be hoped that some student will pursue the matter further, combining a charming holiday with profitable research.

T. D. A. Cockerell.

University of Colorado,
Boulder,
February 21.

The Hermit-Crab and the Anemone.

In Nature of December 2 and 30, 1922, vol. 110 (pp. 735 and 877), there are two very interesting letters from Dr. J. H. Orton on the relationship between these animals and the advantages of the partnership. Many years ago (September 1901) I took the opportunity, after a short visit to Millport, to watch the habits of the species *Eupagurus prideauxii* and *Adamsia palliata*, which seem always to live together, the association presumably being needful for their mutual welfare. Possibly my observations of these may be helpful in understanding the ways of other Paguridæ.

On the occasion referred to, I brought with me to Sheffield a specimen of the hermit-crab and Adamsia living together. To ensure their being undisturbed during my experiments, they were settled by themselves in a small aquarium and regularly fed with oysters and cockles. I thus managed to keep them alive and healthy for nearly six weeks. The Adamsia, as is usual, had attached itself head downwards on the underside of the shell occupied by the hermit-crab, and the two sides of its base had grown upwards and round the shell, so as to meet in the centre above the back of the crab, forming a tube or sack for its accommodation, the crab having far outgrown the small Natica-shell, which, later, was found at the bottom of the sack.

Matters had thus been arranged between the two animals so that, as is well known, the head of Adamsia hung downwards and its tentacles, brushlike, were carried over the surface of the sand when the hermit-crab travelled from place to place. The first two pairs of the long, slender walking legs of the hermit-crab were directed backwards in a manner which suggested protection of the anemone, but this appearance was misleading, as it was soon found that their function, in addition to that of locomotion, was to steal the food collected by the anemone. This was effected most cleverly by an underneath upwards sweep of the leg, the terminal portion of which passed through the tentacles of the anemone and carried any food found therein swiftly to the mouth of the hermit-crab. It is interesting to note that these limbs seem specially adapted to this purpose. The part mentioned (the dactyl) in this species (*E. prideauxii*) is long and very slender, and its inner or concave side is beset with a row of many long fine hairs projecting inwards like the bristles of a brush, thus forming a very effective instrument for sweeping out the mouth of the Adamsia. At times, also, the claws were doubled under the hermit-crab's body and seized the food which had been secured by the anemone. At first food was supplied for the joint use of the animals. Later on I experimented and tried to *feed* the *anemone alone*, but in this I never succeeded, as although the hermit-crab could not see the food, it was so instantly detected and swiftly swept away, as described, that one wondered how the anemone ever got sufficient for its own needs. Whether some sensory hairs on the dactylopodite had anything to do with detection I cannot say.

My observations seem to show that, though both animals benefit, the advantages of the partnership in this particular case are very largely on the side of the hermit-crab, which, in addition to being supplied with food, may possibly derive some benefit from the Adamsia's power when irritated, of firing a broadside of stinging threads through the numerous portholes in its sides. So far as I can see at present, the only profit to the Adamsia is that of being carried from place to place, and thus afforded a better chance of securing food, for which, as has often been pointed out, the downward direction of the mouth and tentacles is most favourable. The anemone may, of course, derive other advantages which are less obvious, and the parallel case (to which Dr. Orton has directed attention) of the little tropical crab, *Melia tessellata*, which carries in each claw a living sea anemone and uses it as a weapon and also (like Adamsia) as a collector of food, suggests the possibility.

On the face of it, Adamsia and the little anemones first mentioned seem to be the willing slaves of the hermit-crabs, for P. H. Gosse's observation, in 1859, of how *E. prideauxii* with its claws transferred the Adamsia from its old shell to a new one ("A Year at the Shore," pp. 241-247), which was later confirmed by Col. Stuart Wortley (*Ann. and Mag. Nat. Hist.*, 1863, p. 388), seems to show that the hermit-crab is the keenly interested active agent in arranging matters so advantageously for itself. With the common hermit-crab (*E. bernhardus*) and *Sagartia parasitica*, however, matters are reversed. Here the anemone evidently takes the initiative, and except perhaps by the camouflage, etc., which is afforded by its riding on the whelk-shell occupied by the hermit-crab, the latter appears to derive no benefit. The position assumed by the anemone is unfavourable to the hermit-crab's sharing in its captures; moreover, the walking legs of the hermit-crab are not adapted to securing a portion, the concave side of the dactyl of *E. bernhardus* being smooth and practically free from hairs, whilst the limb is otherwise unsuitable for the purpose. It seems as though *S. parasitica* has taken a hint from Adamsia and improved upon it.

ARNOLD T. WATSON.

Southwold, Tapton Crescent Road,
Sheffield, March 15.

Paradoxical Rainfall Data.

PROF. MCADIE, in NATURE of March 17, p. 362, directs attention to the apparently paradoxical fact that the wettest month observed in 37 years at Blue Hill observatory fell in June, the month with the lowest rainfall average, whereas the driest month fell in March, the month with the highest average. The coincidence is a curious one, but less improbable than might at first sight appear, since the monthly rainfall is at many stations extremely variable. Some idea of its extreme variability may be gathered from the following table, showing the distribution in half-inch intervals of the rainfall at Rothamsted for 70 years from March 1853 to February 1923.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
0 – ·5		4	1	5	1	3	5		1		1	2	23
·5 – 1·0	9	11	11	8	7	9	5	4	5	4	4	6	83
1·0 – 1·5	12½	19	13	12	18	10	11	13	13	7	11	9	148½
1·5 – 2·0	7½	10	16	14	12	13	7	7	11	14	4	14	129½
2·0 – 2·5	10	8	10	10	12	6½	11	8	17	5	18	7	122½
2·5 – 3·0	9	4	7	12	8	10½	5	13	7	11	11	6	103½
3·0 – 3·5	7	5	4	3	5	5	9	9	6	6	6	10	75
3·5 – 4·0	9	6	4	3	1	5	2	7	2	5	4	3	51
4·0 – 4·5	4	1	3	1	3	2	5	3	3	4	7	6	42
4·5 – 5·0	2	2	1	2	2½	3	5	2	1	3	3	1	27½
5·0 – 5·5					½		2		2	3	1	1	9½
5·5 – 6·0						1	2	1	1	4		2	11
6·0 – 6·5						2				1		2	5
6·5 – 7·0							1	3		2			6
7·0 – 7·5										1			1
7·5 – 8·0													
8·0 – 8·5									1			1	2
	70	70	70	70	70	70	70	70	70	70	70	70	840

The seasonal effect appears to be more strongly marked at Rothamsted, where the mean rainfall (per day) in October is about 54 per cent. greater than that in April, than it is at Blue Hill, where the mean rainfall (per day) in February is only about 24 per cent. more than in June. Nevertheless, even in the Rothamsted data, the variability of rainfall in the same calendar month is so great that the mean values give little or no indication as to which month should be expected to score a record for rain or drought. Indeed, both records are at present held by December, which in 1864 gave one-sixteenth of an inch of rain (0·063), and in 1914 gave 8·103 inches.

R. A. FISHER.

Rothamsted Experimental Station,
Harpenden, Herts.

Rothamsted and Agricultural Science.[1]

By Sir JOHN RUSSELL, F.R.S.

THE Rothamsted Experimental Station has just passed its eightieth year, having been founded in 1843. Its study has always been the growth of crops, with periodical excursions into problems of utilisation; the method of experiment has always been essentially statistical in that the field experiments were repeated year after year without modification, with the result that a unique mass of data has now accumulated which is proving of the greatest value for statistical investigation.

The work at Rothamsted falls into two great periods: the first, when Lawes and Gilbert were actively exploring the possibilities opened up by the knowledge of plant nutrition gained by the early nineteenth-century workers; and the more recent period, when close study of the soil has revealed certain factors of high scientific interest, and, one is constrained to believe, ultimately of great practical importance.

The great problem which Lawes and Gilbert set out to solve was to account for the fertilising value of farmyard manure. The fact was well known, but there was no satisfactory explanation. Lawes and Gilbert proceeded by a method that still—after eighty years—remains our best. It was known that farmyard manure contained three groups of components: organic matter; nitrogen compounds; and ash constituents—potassium, calcium and magnesium salts, phosphates, silicates, etc. They therefore arranged vegetation tests with these various groups. The old idea was that the fertilising value lay in the organic matter, but Liebig, in 1840, had argued brilliantly against this view, and suggested instead that the ash constituents, especially the potassium, calcium and magnesium salts, were the effective agents. Lawes and Gilbert were prepared to recognise the necessity for these mineral salts, but insisted that the nitrogen compounds were equally required. To put the matter to a test, they laid out four plots of ground, receiving respectively no manure, farmyard manure, ashes of an equal amount of farmyard manure, and these ashes plus a nitrogen compound (ammonium sulphate). The results were as follows:

PRODUCE OF WHEAT PER ACRE, BROADBALK FIELD, ROTHAMSTED, 1844.

	Grain. (bush.)	Straw. (cwts.)
No manure	16	1120
Farmyard manure (14 tons per acre)	22	1476
Ashes of 14 tons of farmyard manure . . .	16	1104
Ash constituents + nitrogen compounds and ammonium sulphate, up to . . .	26¼	1772

They concluded that farmyard manure owes its value, not to the organic matter as was for long supposed, nor to the ash constituents as Liebig had suggested, but to the ash constituents plus nitrogen compounds.

Now this discovery was of the greatest importance in plant physiology, but Lawes and Gilbert did not follow it up in that direction. Instead they applied it at once to an important agricultural problem then ripe for solution. There was then (as nearly always now) a shortage of farmyard manure on farms, and agriculturists had for generations sought for substitutes, but with little success. Lawes and Gilbert saw that the mixture of ash constituents and nitrogen compounds would form an effective substitute, and further, that it could be obtained in very large quantities, and of course independently of farmyard manure. Geologists had discovered vast deposits of calcium phosphate, which chemists had shown how to render soluble. Engineers were developing the manufacture of coal gas and producing large quantities of ammonium sulphate, while potassium compounds could be obtained without difficulty from wood ashes. Lawes and Gilbert therefore proceeded to make mixtures of these substances which they advised farmers to use.

Few experiments have proved so fruitful in stimulating scientific inquiry—it is still opening up new fields at Rothamsted—and in ministering to human needs, as this simple field trial carried out eighty years ago on the Broadbalk field at Rothamsted. At first farmers looked with some misgiving upon this new kind of manure (which was called "artificial manure" to distinguish it from farmyard manure, then known as "natural manure"); it seemed incredible that a harmless-looking powder without smell or taste could act as potently as the old-time richly odorous farmyard manure. But they soon came to recognise its value, and before long they were using many thousands of tons a year. It is safe to say that the remarkable development of British agriculture which took place between 1843, when Rothamsted began, and 1870, would have been impossible without artificial fertilisers. During that period British farmers kept pace with the growing needs of the population; indeed they did more, for they helped to change the "hungry 'forties" into the more plentiful 'seventies. The use of artificial fertilisers is now developed throughout the civilised world and the industry has attained enormous dimensions.

This was the greatest achievement of Lawes and Gilbert. They did many other things for the farmers of their day, but this alone leaves us owing them a great debt of gratitude.

As the use of artificial fertilisers spread there arose, as one might expect, many problems of great scientific interest or technical importance. Thus it soon appeared that weather conditions profoundly affected the response of crops to artificial fertilisers. The same fertiliser mixture which in one season gave results fully equal to, or even surpassing those of farmyard manure, would, on the same farm and even in the same field, prove a failure in another season. This is well shown in the fluctuations in yield on the Broadbalk wheat field at Rothamsted.

The effect of soil is also sharply marked. On our heavy soil at Rothamsted the best results are usually obtained by a fairly liberal use of phosphates, but there is less necessity for large dressings of potash. But on the much lighter soil of Woburn potash is considerably more important, while phosphates

[1] Discourse delivered at the Royal Institution on Friday, February 9.

are less needed, and, indeed, beyond a certain quantity appear to do actual harm. It is obvious, therefore, that a complete manure drawn up on the basis of the Rothamsted experiments would fail in practice to give the best results on a lighter soil. As an instance the following may be quoted, this being one of a general scheme of experiments organised from Rothamsted:

Barley: Light Sandy Soil in Suffolk, 1922.

	Bush. per acre.
Complete artificial manure	21·5
Incomplete manure: phosphate omitted	27·5
No manure	16·0

In this instance the omission of phosphates has raised the yield by 6 bushels per acre. As against this, an array of instances might be brought from clay farms where a phosphate is the one and only thing that causes crop increases. Any one who had to deal with

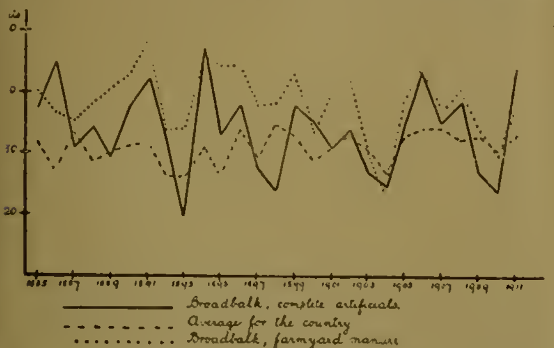

Fig. 1.—Yields of wheat from Broadbalk plots manured with complete artificial manures, and farmyard manure, respectively, compared with the average yield for the whole country.

farmers' problems could multiply apparent contradictions and inconsistencies of this kind. When one collects, as we have done at Rothamsted, the results of field trials with artificial manures made in different parts of the country they seem at first to be simply a tangled mass of unrelated facts.

Now it is the business of the man of science to sort out a tangle of this kind, to reduce it to order, to find the general principles running through it, and finally to prove the correctness of his conclusions by being able to predict with certainty what will happen in given conditions. The recognised method of procedure is to discover the various factors at work and investigate them one at a time. This is being done at Rothamsted in two ways: by field observations, and by quantitative laboratory measurements. Observations in the field show that each of the fertilising substances—phosphates, potassium compounds, nitrogen compounds, etc.—in addition to its general effect in increasing plant growth, produces certain specific effects which may be of advantage, or may be a disadvantage to the plant in the particular conditions in which it happens to be growing. Thus, phosphates have a special influence in hastening the ripening processes, which no doubt accounts for the Suffolk results just quoted. In the dry conditions of a sandy soil, ripening is already too early, and any reduction in an already short growing season cuts down the yield; in cold, wet districts, however, this property is very valuable.

In the early stages of the plant's life phosphates stimulate root development to a marked degree; this is well shown in their effect on swedes. Nitrogen compounds tend to increase leaf development and give greater vigour of growth, but beyond a certain point the advantage is counteracted by a loss of resisting power, and the plants may fall victims to attacks of disease. Crops—especially cereals—may be unable to stand up against the weather and may become "lodged." Indeed, the proper adjustment of plant nutrients affords plant pathologists one method of dealing with plant diseases.

Qualitative observations of this kind, while of high value, are not entirely sufficient: it is necessary to have quantitative measurements of as high an order of accuracy as possible. At Rothamsted this is done by means of water cultures and pot experiments; all the factors are controlled as closely as possible and the results are plotted on curves which can be studied in detail. This method was developed extensively by Hellriegel and is now in common use in agricultural laboratories.

The method naturally invites mathematical treatment, and attempts have been made, notably by Mitscherlich, to express the curve by equations. There is a seductive look about a mathematical formula which rarely fails to appeal to the biologist, but as a rule the number of experimental points obtained is much too small to justify mathematical treatment, and it is not surprising that investigators fail to agree. Ten years ago the fashion was for logarithmic curves; now it is for sigmoid curves, which are probably nearer the truth, though not yet a complete expression.

This method of studying single factors is pushed to a high degree of refinement in plant physiology laboratories, such as that of the Imperial College under Prof. Blackman, or that under his brother at Cambridge, and there can be little doubt that the effect of individual factors on the plant will ultimately be well known. All this work is giving valuable information as to causes and principles.

These curves show the relationship between yield and plant food supply at one particular temperature which remains constant, and one particular water supply which also remains constant. But a completely different set of figures would be obtained if the temperature were different or if the water supply were altered. Supposing one wished to take account of the effect of water supply as well as food, one would draw a series of curves, which would properly be expressed as a surface, and this has been done by one of the Rothamsted workers—Mr. J. A. Prescott—to show the effect of nitrate supply and spacing on the yield of maize in Egypt. The experiments had the advantage that the climatic conditions are less fickle there than here. It would be of the greatest interest to obtain such surfaces for other pairs of factors.

If an attempt were made to study factors three at a time, it would be necessary to prepare a series of surfaces and to embody them in a figure in four dimensions, which is certainly beyond the capacity of the ordinary agricultural investigator. But in agricultural field work the factors do not vary one at the time, or even two or three at the time; there may be half-a-dozen variables. This, of course, enormously complicates any attempt to apply to field conditions the results obtained by these single factor physiological experiments. It is possible that when the physiologists have completely elucidated all the single factors, some one will be able to synthesise the material and build it into some great conception or expression that will contain all, and thus account for the field results. But history shows that the genius capable of effecting a synthesis of this sort is very rare and might have to be awaited long.

We have therefore adopted another method at Rothamsted, which is being worked alongside of the single factor method. Statisticians have, during recent years, been evolving methods for dealing with cases where several factors vary simultaneously. These methods have been applied by Mr. R. A. Fisher to the Rothamsted field data, and he has been able to trace

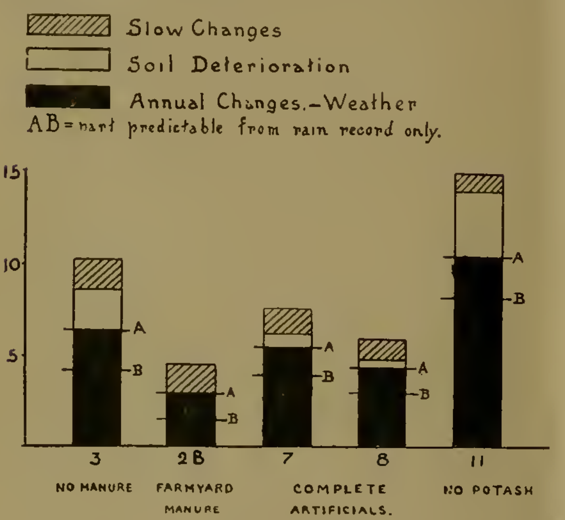

FIG. 2.—Mr. R. A. Fisher's results showing amounts of predictable variation in wheat yields, Broadbalk, Rothamsted.

certain statistical regularities which foreshadow the possibility of important developments.

Thus, the yields on the Broadbalk wheat field vary every year, apparently in a most erratic manner. But analysis of the figures showed that the factors causing variation could be disentangled and expressed quantitatively; there are slow changes in the field, such as changes in the amount of weeds, etc.; deterioration of soil; and weather changes such as rainfall, temperature, etc. (Fig. 2).

As might be expected, the effects differ according to manurial conditions; *e.g.* the influence of weather varies with the manure. Important differences appear between farmyard manure and artificials. The variation in yield is less where farmyard manure is given than where artificials are used. Further, the so-called complete manure appears not really complete at all; there is soil deterioration going on; but with farmyard manure no such deterioration is produced. The different kinds and quantities of artificial manures produce different effects on the variation in yield, the magnitude of which has been worked out.

Having disentangled the factors Mr. Fisher has proceeded to analyse the effect of rainfall, and he finds that part of the weather effect is predictable when rainfall is known. Rain above the average in autumn is somewhat beneficial; in winter and in summer it is harmful, and in spring it is less frequently harmful. As before, the effects are much more pronounced with complete artificials than with farmyard manure. The actual facts have long been known in a general way, but here is an exact quantitative measurement.

The great advantage of this statistical regularity is that it indicates the possibility of expressing in terms of chance the influence of the weather, soil, etc., on crop yields. We hope ultimately to be able to say to the farmer, given such and such conditions of soil and weather, the chances are so many to one that such and such an increase of yield will be obtained by the use of a specified fertiliser. The expression would be understood by every farmer, and he would readily decide whether to take the risk or not.

Much greater results would also follow. At present the farmer cannot cover his risks of low yields by insurance, the companies not yet having sufficient data. We hope and believe that these statistical investigations will afford the basis on which such data will be obtained. At present the position approximates to that of life insurance in the eighteenth century, when the statistical regularity of mortality was first established, after which the first life tables could be constructed. There still remains a mass of detail to work out, but the fundamental problems are now being attacked, and we see no reason to regard them as insoluble. If the expectancy of crop yields proves to be calculable the farmer will be able to insure himself against crop failure, and so meet one of the worst vicissitudes of his troubled life by merely taking out an insurance policy—perhaps even by subscribing to a particular newspaper.

We are constrained to admit that the work is still far from completion, and in the meantime agriculture has fallen on difficult days and farmers are turning to us to ask how they can obtain large crops in the most economical way. It is not general principles they want, but particular instructions.

We are not in a position to give an absolute clear-cut prescription to any farmer, but we are going a long way to meet him. Some of our field experiments of special interest or importance are being repeated at other centres where soil and climatic conditions are all different. The results are compared with ours, or with others that have been obtained, to ascertain how far or in what direction any of our conclusions would need modification in a particular district.

We now return to an important result to which I have already referred. Over a period of years the artificial manures have not proved quite as effective as farmyard manure; there has been more variation in yield and they have not so well maintained the fertility of the soil as farmyard manure has done. On some crops the effect is marked; clover responds better to farmyard manure than to artificials. It appears then that Lawes' and Gilbert's views that the fertiliser value of farmyard manure lay in its ash constituents plus nitrogen compounds is only a first approximation, and that farmyard manure does something or contains something which artificial manures do not. This difference we are now engaged in exploring.

The same method of procedure is used as in studying the effects of artificial fertilisers. A full scientific investigation into the causes is carried out, but simultaneously an attempt is made to find some working solution of the farmers' problems. The shortage of farmyard manure is still as acute as ever, and to keep more animals with the view of making more is uneconomic. At Rothamsted we have attempted to produce farmyard manure from straw artificially and without animals. This has been done by Mr. E. H. Richards and Dr. Hutchison by simulating the essentials of the natural process, namely, watering straw with a salt of ammonia (actually ammonium sulphate, but calcium carbonate is mixed with the straw), and leaving the heap so that the air can get in and the organisms can do their work. The product is not yet equal to the natural substance, but it is steadily being improved, and the very serious difficulties are gradually disappearing in Mr. Richards's competent hands. Five years ago a few ounces only of this artificial farmyard manure had been prepared; last year several thousand tons were made on various farms in different parts of the country, and the news is spreading. The serious problem of developing the work from the laboratory to the farm scale has been possible through the generous and public-spirited action of Lord Elveden. There seems here the possibility of aid to the farmer and of the development of an important new industry.

Meanwhile a full scientific investigation is being carried on to discover wherein farmyard manure differs from artificials. One important difference is already known and is being investigated by Dr. Keen. Farmyard manure opens out the soil particles leaving bigger pore spaces; it allows of the retention of more moisture and the better circulation of air. All these effects are beneficial.

There is also another difference. Farmyard manure and also plant residues (which are substantially the same thing) decompose in the soil, giving rise to many substances of different types. The plant foods are among the end products: indeed, in natural conditions, and, to a large extent, in farms and gardens also, it is in this way that plants obtain their food. In using artificial manures we supply these end products at once instead of waiting for them to be liberated gradually by the natural decomposition. Further, we do not by any means know the whole of the processes whereby plant food is made. But there are certain intermediate products, and it is quite possible that some of these may have a special effect on the growing plant. Curious stimulating effects are produced by substances formed when soil is steamed, or when oxidation is accelerated by addition of charcoal, and we have obtained the same results with small quantities of picric acid; such bodies might well be formed as intermediates in the decomposition of farmyard manure. The whole effect suggests an action like that of the vitamins of plant physiologists or the auximones of the late Prof. Bottomley. The chemical department at Rothamsted, under Mr. Page, is following out the process, and the botanical department, under Dr. Winifred Brenchley, will test any intermediate products which may be obtained.

A further important factor, which probably governs the whole situation, is that a great part of the process of decomposition and plant food production appears to be brought about by living organisms in the soil. Simultaneously, therefore, with the chemical and botanical investigations, the various biological departments are busily engaged in studying the organisms that are doing the work.

It is a wonderful story that is being revealed. The soil is shown to be the abode of a vast population of living organisms of the most varied kind. Some of them are remarkably small; among them one which brings about the last stage in the formation of nitrates—an organism which Rothamsted just missed forty years ago: another, also just missed at Rothamsted, which has the remarkable property of fixing nitrogen in the nodule of the clover plant. Others are larger and more easily picked out, but their exact place in the soil economy is not easy to determine: probably they are concerned in the preliminary stages of the decomposition.

It is impossible to peer into the soil with a microscope, so that indirect methods of exploration have to be used. At Rothamsted the organisms are counted and the work they do is estimated by some chemical process: virtually we take a census of population and production in the soil. Like other census methods, it is comparative only: a single census is not much use; it is not until several have been taken that one can find how the numbers and activities of the population are being affected by various conditions. The census is therefore repeated periodically and the results plotted on curves from which it is possible to deduce the effect of various factors on the particular organisms counted.

These curves brought out the remarkable result that partial sterilisation increased bacterial activity, and investigation showed that the normal virgin soil must contain other organisms besides bacteria—organisms, moreover, which were detrimental to bacteria and tended to keep their numbers down. A search for such organisms showed that protozoa were present: many forms have since been found in the soil, some of which are known to feed on bacteria. Mr. Cutler has discovered how to count them, and with the co-operation of willing workers has succeeded in carrying out perhaps the most remarkable census yet made of the bacterial and protozoan population of a natural field soil. Before the census began many months were spent in perfecting the methods and technique, and in making preliminary studies of the soil. The details were carefully arranged with the statistical department, and it was decided to take the census many times at short intervals. Time to a bacillus or a protozoan is a different thing from what it is to us, and instead of taking the census every ten years, or even every ten days, it was taken daily, and at the same hour every day. Many repetitions were needed so that the statistician might feel safe in drawing conclusions from the data. The census was therefore made every day for 365 consecutive days, and no less than seventeen different organisms were enumerated.

A team of five workers kept the investigation going without intermission—Sundays, Bank Holidays, and Christmas Day—for a whole year. A mass of data was obtained of high statistical value which is proving of the greatest importance in the study of the soil population. One of the most interesting results was the proof that the soil population is not steady in number as had always been assumed, but is in a violent state of flux. Every organism observed—protozoon or bacterium—showed great daily variations, which seemed to be independent of external conditions. At least one showed a two-day periodicity. The fluctuations of the amœbæ were of special interest as they were exactly the reverse of the bacterial fluctuations. Close examination of the curves leaves no doubt that the fluctuations of the amœbæ cause the fluctuations of the bacteria, high numbers of amœbæ causing low numbers of bacteria, and low numbers of amœbæ allowing bacterial numbers to rise: but why the amœbæ fluctuate remains a mystery.

In the case of bacteria it has been possible to make even closer observations. A census organised by Messrs. Thornton and Page has been taken each two hours for several days and nights; but again the same wonderful fluctuations are seen. As might be expected, the amount of work, as measured by the nitrate present, alters from hour to hour. But the curve was not quite what was expected: the increases in amount of nitrate could be understood as representing the work done by bacteria, but the decreases were more difficult to explain. There was no rain to wash it out and there were no plants to take it up; yet the nitrate tends to disappear. The results suggest that some organism is absorbing it. Algæ and fungi could both do this, and both are found in the soil: Dr. Muriel Bristol and Dr. Brierley are closely studying them.

Perhaps even more remarkable than the daily changes are the great seasonal changes. It appears that the whole soil population is depressed in winter and in summer, and is uplifted in spring and autumn. How this comes about we do not know. The phenomenon does not seem to be confined to the soil; the algæ in a pond and the plankton in the sea, like the organisms in the soil, all seem to feel the joy of spring; it is as if Virgil had got hold of some great truth in natural science, which we have not yet been able to express in cold scientific terms, when he says that in spring "Aether, the Almighty Father of Nature, descends upon the earth, and blending his mighty frame with hers, gives life to all the embryos within." ("Georgics," Bk. II. 11, 324-327).

The number of organisms in one single gram of soil—no more than a teaspoonful—often well exceeds 40 millions. This looks big, but it is difficult to form an idea of its immensity. If each unit in the whole array could be magnified up to the size of a man and the whole caused to march past in single file, they would go in a steady stream, every hour of the day and night for a year, a month and a day, before they had all passed. We must think then of the apparently lifeless soil which we tread beneath our feet as really throbbing with life, changing daily and hourly in obedience to some great laws which we have not yet discovered; pulsating with birth, death, decay, and new birth. And if the wonder were not sufficient, we know that in some way these lowly organisms are preparing the food for our crops—the crops on which we ourselves feed. It is possible—it is even probable—that our attempts to learn something of this wonderful population may lead to some degree of control which would have valuable economic results. But even if this never happened the work would still be justified because it shows to the countryman something of the abounding interest of his daily task and of the infinite wonder of the soil on which he spends his life.

The Present and Future of Marine Engineering.

THOUGH shipping and shipbuilding are passing through a period of severe depression it is generally considered that more prosperous times are in sight. The War, as is well known, occasioned tremendous losses to the shipping of the world—we ourselves lost over seven million tons—but this has been more than made up, and the latest edition of Lloyd's Register Book shows that there are afloat to-day, exclusive of sailing vessels and vessels under 100 tons, some 29,000 steam and motor ships of a total tonnage of 61,000,000 tons. This is an increase of some 14,000,000 tons on the figures for 1914, but while in that year the United Kingdom owned nearly 44½ per cent of the world's sea-going steam tonnage our present proportion is just over 33½ per cent. In spite of this, we are still the greatest users of ships and the greatest builders of ships, though to-day shipping returns are only too eloquent of ships laid up, berths empty, shops closed, and machinery idle.

While this is the case, the competition for such orders as are to be obtained has forced all designers to study more closely than ever the economics of shipbuilding and marine engineering, and a vast amount of investigation and research is being carried out. Especially noteworthy are the inquiries being made into the respective advantages of the steam engine, the steam turbine, and the oil engine. As a result of this, the shipowner is to-day offered a bewildering variety of machinery of various types, all of which have their respective merits. A quarter of a century ago marine machinery was more or less standardised. Practically every ship built then was fitted with cylindrical boilers burning coal, and triple expansion engines. Of the 61,000,000 tons of shipping referred to above, 51,000,000 tons are still driven by such engines. Remarkably successful as it has been, the reciprocating steam engine, however, has long been superseded in naval vessels and fast liners by the steam turbine, and now its very existence is threatened, on one hand by the turbine combined with mechanical, hydraulic, or electric transmission gear, and on the other hand by numerous forms of the Diesel internal combustion engine.

The present position of the marine steam turbine is scarcely less critical than that of the triple expansion engine. It is twenty-one years since the marine steam turbine was used commercially, and it is estimated that turbines of more than 50,000,000 horse-power have been fitted in ships. There are many types, such as those of Parsons, Curtis, Rateau, De Laval, Zoelly, and others, but it was the Parsons turbine which led the way. Originally the turbine was connected directly to the propeller shaft. To be economical, however, the turbine should run fast and the propeller slow. To achieve this object, Sir Charles Parsons introduced helical tooth gearing, the turbine shaft having a small pinion which geared into a large wheel in the propeller shaft. Such single reduction gearing was successfully tried in the s.s. *Vespasian* in 1909. Since then double reduction gearing, consisting of a train of four wheels, has been largely used. In this arrangement the pinion in the turbine shaft drives a wheel on an intermediate shaft, and a pinion in the second shaft drives the wheel in the propeller shaft. By this means it is possible to run the turbine at three or four thousand revolutions per minute while maintaining a suitable propeller speed. One of the finest examples of such gearing is found in the latest liner of the Canadian Pacific Railway Company, the *Empress of Canada*. Completed last summer, this vessel is the largest passenger ship running in the Pacific. Of 21,520 tons, she is driven by twin sets of Brown Curtis turbines, each set having H.P., 1st I.P., 2nd I.P., and L.P. turbines, which drive the propeller through double reduction gearing. The main gear wheel on the propeller shaft alone weighs 65 tons, while one complete set of gearing weighs about 200 tons. Additional interest attaches to this installation, due to the application of the principle of the nodal drive devised by Dr. J. H. Smith, of Belfast, in order to avoid trouble due to torsional oscillations of the various shafts.

But while mechanical gearing of this kind has been used extensively, there have unfortunately been serious failures which have given rise to more than a little doubt as to the trustworthiness of such gearing. The elucidation of the causes of the failures is among the most pressing problems facing the marine engineer. References to this were made in the recent presidential addresses of Engr. Vice-Admiral Sir George Goodwin, Dr. W. H. Maw, and of Prof. T. B. Abell to the Institute of Marine Engineers, the Institution of Civil Engineers, and the Liverpool Engineering Society respectively, and the urgent need for further research was pointed out. Failures occur from the wearing or the breaking of the teeth. In some instances where wear has taken place the trouble has not been serious, and with further use the condition of the gearing has improved. When fracture takes place the broken pieces sometimes fall clear of the wheels, and the damage is slight. If, however, the broken teeth are caught in the wheels distortion and crushing takes place immediately, and the gear wheels are rendered useless. The causes of failure have been variously assigned to inaccurate cutting of the teeth, want of alignment of the shafts, improper design, unsuitable or faulty material, and the occurrence of excessive torsional vibrations in the shafting and gearing. This latter subject has been dealt with recently in a valuable paper by Messrs. A. T. Thorne and J. Calderwood, read before the North-East Coast Institution of Engineers and Shipbuilders.

Recent improvements in steamships, whether driven by turbines or reciprocating engines, have been largely concerned with the stokehold. Though cylindrical boilers still remain the rule, water-tube boilers are being fitted in increasing numbers, and in such vessels as fast torpedo craft and cross Channel steamers the combination of the water-tube boiler with the geared turbine is likely to hold its own for a long time. The water-tube boiler leads to a reduction in weight, it can be forced at a high rate of combustion, and it is admirably adapted for use with oil fuel. Naval vessels have used water-tube boilers exclusively for many years, but it is only recently the mercantile marine have taken kindly to them. The most notable example of the use of water-tube boilers in a merchant ship is found in the White Star liner, the *Majestic*, the ex-German ship *Bismarck*, which it is anticipated will run the *Mauretania* very close for the blue ribbon of the Atlantic. The world's greatest ship, the *Majestic*, is 912 feet long, and displaces, when fully loaded, 64,000 tons. The turbines, originally designed for 66,000 S.H.P., are supplied with steam from 48 water-tube boilers of the Yarrow-Normand type. These have a total heating surface of 220,000 sq. ft., or some 40,000 sq. ft. more than the boilers of H.M.S. *Hood*. Like most of the Atlantic liners the *Majestic* is now fitted for burning oil fuel. Some 15,000,000 tons of ships burn oil instead of coal to-day, and provided supplies of oil prove sufficient, the time is not far distant when the coal-burning ship will be obsolete. When used under boilers three-quarters of a pound of oil will do the work of a pound of coal. Then, too, the use of oil-fuel leads to a great reduction in the stokehold staff, and from the shipowners' point of view it has the advantage of making it possible to reduce the time of a ship in port. The *Olympic*, for example, can fill her oil-tanks in six hours; coaling used to take 4½ days.

It is not, however, with the reciprocating engine or with the steam turbine that the future of marine engineering appears mainly to lie, but with the Diesel internal combustion engine. Diesel brought out his engine so long ago as 1893. Its success ashore has been remarkable. For driving ships it has had to serve a long probation. The Atlantic was first crossed by a Diesel-driven ship in 1910. Since then its progress has been more rapid, and practically all marine engine builders have taken up the construction of Diesel engines of one form or another. The motor ship has undoubtedly come to stay, and the placing of an order by the Union Steamship Company of New Zealand with the Fairfield Company for a motor driven vessel of 20,000 tons with a speed of 18 knots marks an important epoch in its history. This notable vessel will be 600 ft. long, and will be driven by four sets of Sulzer two-cycle Diesel engines of an aggregate power of 13,000 H.P. This is twice the power of any motor vessel running at present. Such a step is evidence of the degree of trustworthiness and success achieved by the motor ship.

The credit of building the first motor passenger liner belongs to the Elder Dempster Line, which commissioned the *Aba* for its West African trade last year, and has now placed the *Adda* on the same run. Other companies are following the lead thus given, and while in 1914 there were only 297 motor ships afloat there are now 1620, with an aggregate tonnage of more than one and a half million tons. Shipowners have the choice of a dozen types of Diesel engines, such as the Burmeister and Wain, the Werkspoor, the Sulzer, the Beardmore, the Cammellaird-Fullagar, and the Doxford, some being of the four-cycle and some of the two-cycle type. These engines differ in many respects, but all have the same characteristic in being more economical than the steam engine. Mention may also be made of the experiment being carried out with the Still engine, in which the top of the piston is acted upon by the pressure of the burning gases, while the underside is acted upon by the pressure of steam raised in a small boiler heated by the exhaust gases.

In addition to the advocates of the steam turbine and the Diesel engine there is yet another school of engineers which believes the future of marine propulsion lies with what is known as the electric drive. This system has been developed far more in America than on this side of the Atlantic, and all recent capital ships for the United States Navy have electric transmission. In these vessels oil-fired boilers supply steam to Curtis turbines driving electric generators which supply current to the motors on the propeller shafts. The general adoption of such a system, it was pointed out by Prof. Abell, may lead to remarkable alterations in the plans of ships, as the engine-rooms can be placed between decks or otherwise as thought most suitable. A turbine-electric plant involves the use of boilers, turbines, condensers, generators, and motors, but an alternative is to replace the boilers, turbines, and condensers by Diesel engines. The various proposals have been reviewed in his book on "Electric Ship Propulsion" by Commander S. M. Robinson, of the United States Navy. He there divides both naval and mercantile vessels into classes, and states which type of machinery he considers most suitable. For the cargo tramp he would have Diesel engine and electric drive, for other merchant vessels and for large war vessels steam turbines and electric drive, while for destroyers and light cruisers he would retain geared turbine.

From the foregoing it will be seen that the whole practice of marine engineering is, as it were, in the melting-pot, and what the standard form of marine propulsion will be in the future is difficult to see. Given trustworthiness, it is economy which has the deciding influence; economy in weight, economy in space, economy in upkeep, economy in fuel. What the continual striving after economy has done in the past can be judged by the fact that, fifty years ago, to convey a hundred tons of cargo a mile required 18 to 20 lbs. of coal; to-day the same result is obtained with $1\frac{1}{2}$ to 2 lbs of oil. Finality was thought by some to have been reached when the compound engine was introduced. Great advances have been made since then. But while it may not be possible to effect revolutions on the scale of the past, the time is far distant when improvements will be impossible.

Obituary.

Sir James Dewar, F.R.S.

Sir James Dewar died at the Royal Institution, in his eighty-first year, on March 27. He had been working in his laboratory until late on the night of March 20 and was taken ill in the early hours of the following morning.

Our scientific edifice is thus suddenly deprived of one of its main pillars; we shall not easily appraise the loss. The immensity and sustained originality of his genius, the service he rendered to our civilisation, can be but insufficiently appreciated outside the small circle of intimates who witnessed his work and, having penetrated through the thick mask of modesty and reticence which he habitually wore, could disregard his sometimes brusque, inconsequent manner, his volcanic, torrential outbursts of picturesque criticism—knowing these to be but the expression of an extreme intensity of conviction and purpose and an overmastering honesty. At heart he was full of human sympathy, a most gentle and lovable nature—but the presbyter was ever in him.

As an experimentalist Dewar stood alone: there has never been a greater, probably none so great. Science loses in him a worker of peculiar breadth of originality, a most fascinating character; how much the world is poorer it little knows. He was of a type—almost primitive, in this competitive age, in honesty of purpose—now fast becoming extinct, a lineal descendant of his great countryman, Joseph Black, in no way less successful than his predecessors, Young, Davy and Faraday, in adding to the reputation these pioneers created for the Royal Institution as a centre of scientific discovery and invention. He also made it a social centre of great attraction and cast over it an æsthetic spell which it had not previously known. Davy sought society but did not fashion it. Dewar could rarely be persuaded into it but became himself noted as a host, on account of his own great conversational power and the beauty of the surroundings he accumulated: his home was the salon of science and art.

As a lad Dewar met with an accident which, in after life, he regarded as fortunate. Falling through the ice, he contracted rheumatic fever and was long unable to attend school but became intimate with the village joiner. In those days, Scotland having been in close commercial relation with Italy, fiddles abounded and the lad had musical tastes. With his own hands he made several violins, from one of which we heard the sweetest of music conjured forth, by a skilled lady performer, on the occasion of the celebration of his golden wedding, less than two years ago. He always regarded the training he thus received as the most important part of his education and the foundation of the great manual dexterity which he displayed in his work and his lectures. He often complained to me of the sad lack of such ability in the modern student. His master in chemistry was Lyon Playfair. Dewar was one of the few who could appreciate Playfair's great scientific ability and were able to gauge the loss of his early deflexion into the tortuous paths of politics, which Playfair himself regretted in later life. The two men became fast friends and Playfair was long chief admirer of his pupil's brilliant ability. At one time, I believe, Playfair endeavoured to secure his entry into the dyestuff industry; had Dewar's masterful energy been operative in this field our position to-day might well have been one of unrivalled supremacy.

Dewar also came under Kekulé's influence at Ghent. Körner was then assistant in the laboratory and Dewar and he became associated in all sorts of devilry—Körner being a great practical joker and Dewar a wild young Scot. The stamp of the organic chemist was thus burnt into his soul at a critical period—the spell of Körner's marvellous preparative skill being cast over him; he often referred to the time. His mathematical and physical proclivities were thus broadened and he became a complete chemist in spirit. The Dewar benzene-formula, though an imperfect expression of modern knowledge—paper formulæ are but short-hand expressions of character—has not yet lost its vogue. His name is also written in the pyridine chapter. He and I were the first users of sulphuric chlorhydrol, SO_3HCl. He did notable work before he came south—first with Tait, in which he laid the foundation both for his later application of a vacuum in preventing heat exchanges and of charcoal as an absorbent; and with M'Kendrick, with whom he carried out an important inquiry on the physiological action of light.

In 1875 he was appointed Jacksonian professor of natural experimental philosophy in the University of Cambridge and became the colleague of Prof. Liveing. He never carried out the prime duty of his office—the discovery of a cure for the gout—though in early days he sought unsuccessfully for the qualification which might have helped in the work; unfortunately, he only spoilt his digestion and so, in later years, was perforce an extraordinarily careful liver.

Two years after his appointment at Cambridge he also became Fullerian professor of chemistry at the Royal Institution, London. He had twice lectured there previously on the work he had done with M'Kendrick. The second lecture (March 31, 1876), his trial trip, was probably the most carefully prepared, certainly the most logical, discourse he ever delivered; I well recollect how fascinated some of us were by it.

Even if it be possible for a man to serve two masters, the task becomes beyond human power when ghosts aid one of them. As an artist, Dewar had the innate belief of primitive man in ghosts and in the Royal Institution laboratory, miserable as was the accommodation it afforded, the ghosts of Davy and Faraday were ever about him. Let us hope that his successor will be gripped by thoughts of the trinity which Dewar's entry into their Valhalla has established. To have served the Institution honourably, in a way to justify mention in history on a par with them, is an achievement he, in his modesty, scarcely contemplated as possible and yet he ever aimed at it. The feeling that he had so much exceeded Faraday's period of office and not only maintained but also steadily improved the quality of his work, I have reason to think, was year by year a more and more powerful mainspring of action in the indomitable fight against circumstances which he waged during these late bitter times of strife. He was a terrible pessimist.

To return to Cambridge, he found there no tradition of practical achievement to influence him. His colleague Liveing and the Master of his College, Dr. Porter, were perhaps the only men who fathomed his outstanding ability. The crudity of youth was still upon him and the free manners of a Scottish University were not those of conventional Cambridge—his sometimes imprecatory style was not thought quite *comme il faut* by the good. No attempt was made to tame him or provide means for the development of his special gift of manipulative skill. Yet he soon began to exercise an influence which probably has had more to do with the marvellous recent advance of the Chemical School at Cambridge than is commonly supposed. The fine volume of collected researches in spectroscopy which Prof. Liveing and he published a few years ago, is a memorial not merely to their activity but of the example they set as exact observers in a field which, at that time, was in sore need of cautious workers. And the work he did in London had its reflex effect at Cambridge.

Dewar was not great as a teacher. His mind was of too original and impatient a type. He never suffered fools gladly and students are too apt to be foolish—at our old Universities, even to ape the part of superior beings. His forte lay in directing competent hands, not in forming them. He worked himself and through skilled assistants, not through pupils. He was violently impatient of failure in manipulation and his work was almost entirely manipulatory. He, therefore, never created a school. The pity of it is that circumstances were such that he never had a properly large staff. That he accomplished so much with the assistance of the few able men who have aided him is proof of his exceptional skill as a director. It is unfortunate that the Davy-Faraday laboratory was not, from the beginning, organised on lines which would have placed its resources in his hands rather than at the disposal of undirected individual workers; it is a grievous fact that he leaves no followers trained to use his incomparable methods.

Nominally a chemist, Dewar's work lay in fields of his own creation, not borderlands but regions before uncultivated. He was no mere experimentalist but an artist to his finger-tips and in nose, tongue, eye and ear—a perfect judge of *Wein*, *Weib* and *Gesang*, giving to these terms their widest significance; music came next to science in his affections.

Though deeply read and a great lover of poetry and literature, he lacked the gift of ready literary expression—except in his letters and conversation—and was often an incoherent lecturer, yet his lectures were the most masterly and fascinating displays ever witnessed. He set a standard which has made the Royal Institution table remarkable throughout the world. Faraday was celebrated for the simplicity of his style—Dewar is to be thought of on account of the daring of his displays, the wonderful refinement and appositeness of his demonstrations, all most carefully arranged and rehearsed in advance. He was a great scientific actor, playing plays with the most thrilling of plots and entirely original special scenery for each performance. His manner, his brogue, even his impatience, gave a peculiar charm to the impression he produced; but you did well to have been behind the scenes if you wished to gather the full meaning of his message. His demonstrations were unique in character; few realise the infinite loving care he devoted to their preparation. In their simplicity they were often profound. I can never forget the impression I received when I first saw him burn diamond under liquid air—the gradual accretion of the carbon dioxide snow-shower and the blueing of the fluid by ozone, also demonstrated by the iodine test. Then the rapid uprush of the mercury in a barometer-tube full of air when the tube was cooled with liquid hydrogen: it all but knocked the top off. Or again, the production of ozone at the surface of solid oxygen by the impact of ultra-violet radiations. At such moments—and there were many such—the heart beat with joy at the significance of his feats of inspiration.

To the outside world Dewar is known as the man who liquefied oxygen and other gases and as the inventor of the vacuum flask—his name will probably go down the years on this last account. It is due to his memory that this should be spoken of henceforward as *the Dewar flask*: it was his free gift to the public; had he protected and developed the invention he might have amassed a fortune and fully endowed his chair.

The real value of his work on gases, apart from the impetus it gave to the industrial use of liquefied air in particular, is to be found in the many new directions in which he developed the art of inquiry at low temperatures. Perhaps the most illuminating is the inquiry into the heat capacities of the elements at the temperature of boiling liquid hydrogen: the discovery of a periodic variation, corresponding with that in atomic volume at ordinary temperatures, is not only surprising but may well prove to be of profound significance in the future interpretation of atomic properties in terms of electronic structure.

Like his great predecessor, Dewar leaves a mass of material to be interpreted by his successors. Unfortunately, he was all too careless in placing his work on record. Like Turner, he painted for his own pleasure, to give expression to his genius—but too often did not put the picture aside for a Ruskin to glory over.

In two essays printed in the Proceedings of the Royal Institution—one on the "Charcoal Vacuum Septennate" (1909), the other on the "High Vacuum Septennate" (1917)—I have briefly summarised his later and chief work at low temperatures; in the latter I also briefly review his work generally as Fullerian professor up to 1917. These essays may serve to guide students. With him, however, we lose a vast unrecorded experience.

Of late years he had returned to a first love—the soap film: it saved his life and was his solace, keeping him from utter despair during the War. He only left it to go to his last bed of sickness. It is to be feared the record of the work is a very imperfect one. Those who were at his last lecture on "Soap Films as Detectors," on the opening of the Friday evenings this year, will not forget the occasion. He was obviously in physical distress and feeble but mentally as alert as ever; the artist was never more to the fore. His appeal was that made in Cory's beautiful *Incantation*.

My sun is stooping westward. Entrancèd Dreamer haste,
There's fruitage in my garden that I would have thee taste.

But he was the "entrancèd Dreamer"—the fruitage he gave us to taste was lovely; nothing so exquisite had before been brought in such perfect form under the public eye. He recalled Young to us; then, playing with a delicate pencil of air upon his liquid lute, he made visible, in hues of the rainbow, the multitude of its melodies, during over a third of his hour. He had never before lingered so long over a single demonstration. He knew that we were gazing upon no mere play of colour but upon a dance of the molecules such as is at the root of life—and death!

How many of us were serious listeners to the message he felt was to be his last, that he was most bent on making, to his urgent appeal on behalf of the Institution which he had served so long, so well, so nobly—was to serve even up to the moment of his death? He will have worked to no purpose if his appeal be unregarded. The fate and future of science in our country is at stake: nothing less. The Egyptians, thousands of years ago, could make worthy provision for the soul of a boy king of eighteen who had done nothing. Surely our civilisation cannot be so backward, so thoughtless, so unmindful of its present peril, that it will not properly maintain an altar and a virile priesthood to keep alive the memory of men like Davy, Faraday and Dewar in the one way they would all wish—by extending their works in the service of mankind, to its salvation.

H. E. A.

Prof. A. S. Butler.

Arthur Stanley Butler, emeritus professor of natural philosophy in the University of St. Andrews, died at his residence at Upper Redpits, Marlow, Bucks, on March 3. He was a worthy scion of a family distinguished in the church, in education, in letters, and in athletics. His grandfather, the Rev. Dr. George Butler, senior wrangler, was the distinguished headmaster of Harrow; one uncle was Dr. Henry Montague Butler, master of Trinity College, Cambridge, whose charm of manner he possessed; another uncle was the well-known Arthur G. Butler, Dean of Oriel, a not undistinguished athlete. His father, the Rev. George Butler, D.D., at one time vice-principal of Cheltenham College, was latterly Canon of Winchester; his mother, Mrs. Josephine Butler, an author, philanthropist, and active pioneer in higher education of women.

Prof. Butler was born on May 17, 1854; educated at Cheltenham and at Exeter College, Oxford (of which his father—a Hertford scholar in his day—had been fellow), where he obtained first class in Moderations (mathematics) and first-class honours in the Final School. After further study at Oxford, at Cambridge in the mechanical workshop under Prof. James Stuart, and at Liverpool, he was appointed to the chair at St. Andrews in 1880.

Prof. Butler's experience, especially at Cambridge, made him realise how desirable it is that students of natural philosophy should carry out some experimental work in addition to attending lectures and class demonstrations. But like his predecessor, Prof. Swan, he had the difficulties of want of accommodation and suitable apparatus. In the first year at St. Andrews a special grant provided him with some necessary apparatus, and in a few years he succeeded in obtaining a good practical laboratory well furnished: and then all his students were required to do some practical work.

As a lecturer Prof. Butler was highly successful. His lectures to the ordinary class were characterised by definiteness, with clear, simple, and eminently helpful expositions from fundamental principles; they were illustrated by most successful class experiments and demonstrations highly appreciated and much enjoyed, and were occasionally illuminated by quiet flashes of kindly wit: these were especially effective on the rare occasions when any student tried to make a disturbance. But probably he was at his best in his honours class, where his theoretical treatment was often very elegant and his demonstrations much to be admired.

Prof. Butler was well read, particularly in geography—he was a medallist of the Royal Geographical Society—Napoleon's Wars, and the Peninsular Campaigns. For many years he did much work as an examiner in Mathematics, Pure and Applied, and in English for the Civil Service Commissioners.

SIR WILLIAM THORBURN, K.B.E., C.B., C.M.G.

THE death of Sir William Thorburn, on March 18, at sixty-one years of age, is a loss which will be severely felt in the obscure fields of neurology and surgery which his scientific mind and clinical acumen did so much to illuminate.

William Thorburn was the eldest son of the late Dr. John Thorburn, professor of obstetrics in the Victoria University of Manchester, and obstetric physician to the Manchester Royal Infirmary. He entered the Owens College (afterwards the Victoria University) in 1876 and had a distinguished academic career. He obtained the B.Sc. London in 1880, the M.B. and B.S. in 1884, taking gold medals in medicine, obstetrics, and surgery, with a scholarship in medicine. He proceeded to the M.D. in 1885 and the F.R.C.S. in 1886. On the death of his father in 1885 he took up surgery and held junior posts until he was elected on the honorary staff of the Royal Infirmary in 1890, becoming full surgeon in 1901 and consulting surgeon in 1920.

With a particularly acute and logical mind influenced by the teachings of the late Prof. James Ross, Sir William Thorburn was early attracted to the problems presented by injuries of the nervous system, and his first contribution to medical literature was a paper on "Obstetrical Paralysis," published in the *Medical Chronicle* in 1886; this was followed by a paper on "Injuries of the Spinal Cord" published in 1887 in *Brain*. In the field of research thus early indicated he was a pioneer, and his work resulted in various publications which have made him for many years past a recognised authority all over the world on the surgery of the spinal cord.

In 1891 Sir William Thorburn obtained the Jacksonian prize of the Royal College of Surgeons and was later Hunterian professor; he was also president of the Neurological Section of the Royal Society of Medicine.

Sir William Thorburn was always interested in medical education; a first-rate teacher himself, he trained many who are now teachers in our medical schools, and was successively surgical tutor, lecturer on surgical pathology, professor and emeritus professor of clinical surgery in the University of Manchester. His wise advice and willing help were of great value to the University, not only in the organisation of surgical teaching but also in its general policy and administration. As an examiner he had great experience, particularly at the Royal College of Surgeons, where he was chairman of the Court of Examiners and at the Universities. During the War he was at first, as lieutenant-colonel, in charge of the surgical division of the Second Western General Hospital, afterwards serving with great distinction as consulting surgeon in France and the Mediterranean. He was knighted in 1919.

Of distinguished personality and strong character, with decided opinions, and a fluent and witty speaker, Sir William Thorburn will long be remembered with affection by all who came under his influence.

Current Topics and Events.

As already announced (p. 439), the Government, at the last moment, in deference to the general protest, dropped its proposal to make a charge for admission to the British Museum. It was agreed in the House of Commons on March 26 to delete the clause in the Fees (Increase) Bill which gave power to the trustees of the museum to make regulations imposing charges for admission. The old Act of Parliament remains in force, under which the British Museum is, in the words of Sir Hans Sloane, "preserved and maintained, not only for the inspection and entertainment of the learned and the curious, but for the general use and benefit of the public to all posterity." The public, which has saved its rights, should be grateful to the trustees that they did not adopt the easier course of accepting the Government proposals. Had they done so they would no doubt have placated a Treasury rightly eager to cut down the estimates. They preferred, as trustees for the nation, to take higher ground. As a consequence it seems probable that they will have to renew the fight for an adequate appropriation, if not on this budget, at all events next year. Let the public, and especially the scientific public, be quite clear on this matter. Nobody will wish to gain his freedom of admission at the cost of hampering the curatorial and scientific work of the museum. But that this would be seriously hampered by any further reduction, there is no doubt. When such items as printing, binding, glass-ware, and cases for storage and exhibition are about doubled in cost, even an amount equal to the pre-war grants is hopelessly inadequate. No cutting down can be tolerated. Let the trustees continue to maintain a firm front in the highest interests of the nation, and they will be assured of national support.

ACCORDING to an evidently inspired article in the *Children's Newspaper* for March 17, Dr. Alfred Daniell, of Edinburgh, author of a well-known "Text-book of the Principles of Physics," has elaborately reconsidered the whole theory of the Michelson-Morley experiment to his satisfaction, and has come to a revolutionary conclusion. Dr. Daniell does not care to debate whether the shift of interference bands expected by Michelson is likely to occur, or whether the smaller value elaborately worked out towards the end of his life by Prof. Righi of Bologna is more likely to be correct. For according to him it is not the shift of bands that is important, but the fact that such bands appear at all. He has convinced himself that in the Michelson experiment no interference bands ought to appear unless there is an enormous relative motion between earth and ether. Hence, from the fact that interference bands do appear in every repetition of the experiment, Dr. Daniell concludes that such relative motion, amounting to 12,000 miles a second, is proved to exist. As the interference part of the Michelson-Morley experiment is of a straightforward and elementary character, it is difficult to understand how Dr. Daniell can have persuaded himself, and can seek to persuade others, that a motion of the ether is necessary in order to account for the appearance of interference bands when a beam of light is split into two halves and afterwards reunited. The premises upon which this deduction is based are not clearly stated in the article, though several equations are given from which it is apparently deduced, but they must include an error which Dr. Daniell has overlooked.

Sir Arthur Keith, in the first of his Hunterian Lectures on "Man's Posture: its Evolution and Disorders," which appears in the *British Medical Journal* of March 17, reviewed the results of recent investigations which throw fresh light on how, when, and where man came by his erect attitude. He pointed out that extinct forms of man indicate that the upright carriage of the head was evolved later than the human form of the lower limb, of which the origin must be sought in Miocene or possibly Eocene times. He distinguished three phases of evolution. In the hylobatic phase the gibbon was differentiated from its cousins, the Old World and New World monkeys, by postural adaptations of bones and muscles in virtue of which it was orthograde and human in type as opposed to the pronograde monkeys. This differentiation probably took place towards the end of the Eocene period. The troglodytic phase was represented by the great anthropoid apes, evolved from the small anthropoids probably in pre-Miocene times. In the plantigrade phase, structural changes were confined almost entirely to the lower limbs. Seeing that man shares so many characters in common with the great anthropoid apes, Sir Arthur Keith held that man must be regarded as one of several aberrant branches of one great stem which began to break up into the various fossil and living forms at the beginning of the Miocene or the end of the Oligocene period.

Visitors to Kew during the next few weeks should make a point of seeing a special exhibit of sports requisites arranged in Museum IV., the Museum devoted to British forestry. In this exhibit are to be seen cricket bats, tennis and badminton rackets, croquet mallets and balls, hockey sticks, and other articles in various stages of manufacture. Special interest is attached to the cricket bat, for, among the many thousands of woods known to science (upwards of 5000 kinds are represented in the Kew collections), no wood has been found that makes a suitable substitute for the best English willow (*Salix cærulea*) for the blades of bats. The material for the handles cannot be grown in the British Isles; that is the product of one or more tropical palms, *Calamus* spp. (Sarawak Cane). The heads of hockey sticks, the frames of tennis and badminton rackets, cricket stumps, and the handles of croquet and polo mallets are made of the best British ash, while croquet balls are often made of beech, and polo balls of willow. Various other articles are shown, but those mentioned suffice to indicate how dependent the sport-loving public is upon the home-grown timber industry.

The Director of the U.S. Coast Geodetic Survey announces that Congress, at its recent session, made an appropriation of two thousand dollars to the State department for the support of the International Latitude Observatory at Ukiah, California, during the fiscal year 1924, or until some other provision is made for that station. In the estimates for the Coast and Geodetic Survey for the fiscal year 1924 there was included an item which, if it had been approved by Congress, would have authorised that bureau to carry on the variation of latitude observations at Ukiah as a part of its regular geodetic work. It is hoped that this authority will be granted during the next session of Congress in order that there may be no possibility of a break in the observations for variation of latitude which have been made continuously at Ukiah for the last twenty-three years.

While the specification and measurement of artificial light has been brought to a very fair state of precision, there has, until recently, been little corresponding advance in dealing with natural illumination. The chief work in this field has been in connexion with the design of windows for schools, and an exhaustive report on this subject was issued by a committee of the Illuminating Engineering Society shortly before the war. A very complete survey of natural lighting, accompanied by an account of some highly interesting methods of measurement, was presented by Messrs. P. J. and J. M. Waldram at the meeting of the Illuminating Engineering Society on March 27. These methods are based on the relation between the value of unrestricted outdoor daylight illumination, and the illumination at a specified point in a room, a factor which should be substantially independent of climatic conditions and should serve as an indication of the access of daylight. Of special interest was the account of methods of estimating the effect of obstructions to light and the predetermination of daylight-access in buildings. These have recently proved extremely valuable in ancient light cases. Mr. J. W. T. Walsh gave some account of the work on parallel lines being done at the National Physical Laboratory, and paid a high tribute to the experimental skill revealed in the paper.

It is stated in *Science* of March 16 that Mr. A. H. Fleming, of Pasadena, for many years president of the board of trustees of the California Institute of Technology, and its chief financial supporter, has recently given the Institute about 840,000*l*. as a permanent endowment fund. This gift, with Mr. Fleming's previous donations, make a total of more than a million sterling, which he has handed over to the Institute. In making this benefaction, Mr. Fleming recommends that the Institute should "specialise in research in chemistry and physics, under the direction of the most competent men obtainable, with the most liberal provision, in the way of salaries and equipment, for the prosecution of such work." He suggests that efforts should be made to seek out and assist "the superior student," and expresses his conviction that "the institute should always remain a privately endowed institution."

The Paris correspondent of the *Times* announces that at a conference presided over by M. Le Trocquer, Minister of Public Works, on March 31, it was decided to recommend that Strasbourg time as well as summer time should be abandoned, but that during the summer trains should run half an hour earlier. It is hoped that work in Government offices will begin half an hour earlier from April 28 to November 3, and that business and manufacturing firms will adopt the same course. The Brussels correspondent of the *Times* reports that the Royal order fixing the establishment of summer time in Belgium for midnight on March 31 has been revoked, pending an agreement with neighbouring countries.

The lectures at the Royal Institution after Easter begin on Tuesday, April 10, when Sir Arthur Keith will deliver the first of a course of four lectures on the machinery of human evolution. On following Tuesday afternoons there will be two lectures by Prof. A. C. Seward on the ice and flowers of Greenland and the arctic vegetation of past ages; and three by Prof. Flinders Petrie on discoveries in Egypt. On Thursday afternoons, commencing April 12, Prof. A. O. Rankine will give two lectures on the transmission of speech by light; there will be three lectures by Prof. J. T. MacGregor-Morris on modern electric lamps, two by Prof. E. G. Coker on engineering problems solved by photo-elastic methods, and one by Sir William Bayliss on the nature of enzyme action. Two Saturday afternoon lectures will be given by Dr. Leonard L. B. Williams, on the physical and physiological foundations of character, and two by Dr. Arthur Hill on the vegetation of the Andes and the New Zealand flora. The Friday evening meetings will be resumed on April 13, when the discourse will be delivered by Prof. W. H. Eccles, on studies from a wireless laboratory. Succeeding discourses will probably be given by Major W. J. S. Lockyer, Prof. C. V. Boys, Prof. F. Soddy, Prof. W. A. Bone, Mr. W. M. Mordey, and Prof. H. A. Lorentz.

The council of the Geological Society has awarded the proceeds of the Daniel Pidgeon Fund for the present year to Mr. Howel Williams, of the University of Liverpool, who proposes to investigate the stratigraphy and vulcanicity of Snowdon.

In view of the need for retrenching expenditure, the Government of India has decided to discontinue the publication of the Journal and Bulletins of Indian Industries and Labour after the issue of Vol. III. Part 1 of the Journal and of the Bulletins which are now in the press.

The Secretary for Mines has appointed a sub-committee of the Explosives in Mines Research Committee to carry out investigations on the means employed for firing explosives. The members are: Sir Frederick L. Nathan, Mr. J. D. Morgan, Mr. W. Rintoul, and Prof. R. V. Wheeler.

The following sympathetic message has been sent by the King and Queen to Lady Dewar through Lord Stamfordham: "The King and Queen have heard with much regret of the death of Sir James Dewar and desire me to express their true sympathy with you in your loss—a loss which will be shared by the whole world of science."

The Prince of Wales has, according to the *British Medical Journal*, signified his intention of being present at a dinner to be held on May 15, to celebrate the one hundred and fiftieth anniversary of the Medical Society of London. Lord Dawson of Penn, president of the Society, will preside, and a gathering widely representative of the medical profession is expected. The Medical Society of London, which was founded by Lettsom in 1773, is the oldest medical society in England; the Royal Medical Society, Edinburgh, is somewhat older, being founded in 1737.

At the annual general meeting of the Ray Society on March 16, the following officers were re-elected:—*President*, Prof. W. C. McIntosh; *Treasurer*, Sir Sidney F. Harmer; *Secretary*, Dr. W. T. Calman. Mr. Joseph Wilson was elected a vice-president, and Mr. C. H. Beston and Mr. H. Taverner were elected new members of council. In the report of the council it was announced that the final part of Prof. McIntosh's "British Marine Annelids" would be published at an early date, forming the issue to subscribers for the year 1921. On behalf of the Society, congratulations were offered to the president on the completion of this monograph, of which the first part was published just half a century ago. The fifth and final volume of the "British Desmidiaceæ," prepared by Dr. Nellie Carter, is now ready for press, and will be issued to subscribers for the year 1922.

The issues of the *New Leader* from February 9 to March 9 contain a series of articles on "The Structure of the Atom," by the Hon. Bertrand Russell. These articles provide an interesting popularisation of modern work in atomic physics. Thus the idea that the universe seems like a clock running down, with no mechanism for winding up again, is compared with the experience of a tribe of insects which live for only a single spring day, and may therefore think it strange that there should be ice in the world, since they would find it always melting and never being formed. The electron moving from one stationary state to another is compared to a flea, which crawls for a time and then hops; or to a man who, when he is insulted, listens quietly for a time, and then suddenly hits out. It is perhaps difficult for a technical reader to assess correctly the value of a popular article, but in this case a high standard appears to have been reached.

THE National Research Council of Japan has commenced the issue of journals dealing with astronomy and geophysics, chemistry, physics, geology and geography, botany, zoology, medical sciences and engineering, at intervals determined by the amount of matter available. The first six of the ten parts of the *Japanese Journal of Physics* for the year 1922 have been issued and cover 48 pages of original contributions, including one on the band spectrum of mercury by Prof. Nagaoka, and 26 pages of abstracts of 71 papers published by Japanese workers, and supplied by the authors themselves. The whole of the Journal is in English, and this fact will lead to a better knowledge and appreciation of the large amount of research work which is now being done in Japan.

THE Australian National Research Council has issued a report of its annual meeting held in Sydney in August last. The council was formed for national and international purposes in January 1921 by the Australian Association for the Advancement of Science, to which body it has to submit a full report of its work and proceedings on the occasion of each meeting of the Association. At the meeting Sir David Orme Masson was elected president of the council in succession to Sir Edgeworth David. Resolutions were passed urging the need for the State endowment of systematic research in the Pacific islands under Australian control, for research work in Australia in respect of refrigeration, and for laboratories to carry out industrial investigation and research. Offers of co-operation with the Commonwealth Institute of Science and Industry in measures for furthering these objects were made, and preliminary steps taken for the inauguration of a publicity campaign for the purpose of securing that the functions, operations, and financial needs of the Institute may be more fully appreciated by the Commonwealth Government, the Legislature, and the public generally. The council has decided to ask the Australian Association to regard it as a fully constituted body free to conduct its own affairs subject to instructions from the International Research Council. The first issue of *Australian Science Abstracts*, published by the Australian Research Council as a quarterly journal of abstracts of papers by Australian scientific workers, appeared on August 1, 1922. An invitation has been issued by the Commonwealth Government through the Research Council to the representatives of the Pan-Pacific Scientific Congress to hold the Congress in Australia in 1923.

THE Third Report of the Council of the National Institute of Agricultural Botany reveals satisfactory progress in the establishment of the work of the Institute upon a firm basis. The appeal for fellows has met with a gratifying response, and special interest attaches to the fact that the Prince of Wales and the Duke of York have consented to become honorary fellows. In the Crop Improvement Branch the conditions have now been settled on which yield trials of cereals will be carried out, and four new barleys were included in the "full trials" in 1922 at four different stations. The final year's trials will be carried out in the same districts in the spring of 1923. Varieties of oats, wheat, grasses, and clovers are all under observation, and the Institute is collaborating with the Plant Testing and Registration Station of the Board of Agriculture for Scotland, in the collection of strains of certain grasses and clovers, with the view of collecting information as a basis for a future scheme of trials and registration. Special research has been carried out by the official Seed Testing Station as to the value of "hard seeds" in clovers, and of the "broken growth" which occurs in germination tests. Increases have been made in the fees charged for seed testing in order to reduce the net cost of operating the station. At the Potato Testing Station, Ormskirk, various trials of immunity, maturity, and yield have been steadily carried on, more than 2000 entries being received for the official immunity tests. Progress has been made in the work of the Potato Synonym Committee, and less synonymous varieties are now being entered for the immunity trials.

THE second Sorby Lecture, delivered in the autumn of 1921 by Prof. C. H. Desch, has recently been published and is entitled "The Services of Henry Clifton Sorby to Metallurgy." As Prof. Desch remarks, Sorby was one of those amateur lovers of science who have played such a remarkable part in the scientific history of this country. Some have been members of noble families, such as Robert Boyle in the seventeenth and Henry Cavendish in the eighteenth centuries. Others have been men of the merchant or professional classes, possessing sufficient means to allow them to follow the bent of their minds. Such were Justice Grove, William Spottiswoode, Edward Schunck, and, greatest of all, Charles Darwin. To this group belonged Sorby. Free from the cares of a profession, he gave himself wholly to science, in the effort to advance which he worked with extraordinary diligence throughout a long life. Sorby was a pioneer in many branches of science, but left it to others to develop his new experimental methods and to fill in the details of his discoveries. His great manipulative skill and patience led him to found at least two new departments of experimental science—microscopical petrography and metallography. Prof. Desch has attempted to discover in the wide range of Sorby's scientific work, some connecting thread among the great diversity of his investigations, and he finds that a prominent motive in his work is the desire to understand the "form" of natural objects, using this word in its widest sense. The address deals, in the main, with that branch of Sorby's work which led to the foundation of metallography as a science. It is based on a careful study of his note-books and specimens, and may be commended to all those interested in this matter, as an impartial and penetrating survey of the subject.

We have received from the Eastman Kodak Company their latest catalogue, No. 9, dated January 1923, of organic chemicals. There are 1500 chemicals listed, with prices, most being products of the Eastman Kodak laboratories.

The latest catalogue (No. 8, 1923) of second-hand books issued by Mr. W. H. Robinson, 4 Nelson Street, Newcastle-on-Tyne, although dealing mainly with works in general literature, contains sections devoted to voyages and travel, folklore, and books relating to the north country. The prices asked appear to be very reasonable.

The announcement list of forthcoming books just received from Messrs. Methuen and Co., Ltd., contains particulars of many works of scientific interest, several of which are translations. Consideration of space permits reference to only a selection of titles. Among the translations are "The Origin of the Continents and Oceans," Prof. A. Wegener, translated, from the third German edition, by J. G. A. Skerl; "The Principle of Relativity," Profs. Einstein, Lorentz, Minkowski, Sommerfeld, and Weyl, translated by Drs. G. B. Jeffrey and W. Perrett; "The New Physics," Prof. A. Haas, translated by Dr. R. W. Lawson; "Atomic Structure and Spectral Lines," Prof. A. Sommerfeld, translated by H. L. Brose; "Recent Developments in Atomic Theory," Prof. L. Graetz, translated by Dr. G. Barr; "Crystals and the Fine-structure of Matter," Prof. F. Rinne, translated by W. S. Stiles; and "The Mechanism and Physiology of Sex Determination," Prof. R. Goldschmidt, translated by Prof. W. J. Dakin. Of the English science books in the list we notice the following: "Interfacial Forces and Phenomena in Physiology," Sir William Bayliss; "A Manual of Histology," Prof. V. H. Mottram; "A Text-book of Intermediate Physics," H. Moore; and "The Vault of Heaven," Sir Richard Gregory.

Our Astronomical Column.

Meteors of March 17.—Mr. W. F. Denning writes to record that several conspicuous meteors were observed on March 17. At 7 h. 9 m. a fireball was seen from near Durham, travelling from a point considerably south of the Pleiades to α Andromedæ. Its motion was slow, and it left a trail which, however, quickly disappeared. The radiant point was probably in Canis Major, near the bright star Sirius.

At 10 h. 8 m. a rather bright meteor of first magnitude was seen by Miss A. Grace Cook at Stowmarket. It passed through the eastern region of Canis Minor and was directed from near β Geminorum. It left a train. The same meteor was seen from Bristol, and it traversed a short path between α and ζ Boötis, the direction being from β Boötis. A comparison of the observations shows the radiant to have been at 309° + 76°, and that the height of the meteor was from 66 to 48 miles over the region of Epsom and Horsham. The shower in Cepheus to which the meteor belonged was seen in the third week of March, both in 1877 and 1887. At this period of the year it supplies rather bright meteors with slow motions and trains. It appears to be an annual display, and a radiant in the same position has been observed at other periods of the year, notably in August, September, and October.

The Brightening of Beta Ceti.—*L'Astronomie* for March gives a few more particulars of the observations of this star in February. Mr. William Abbott telegraphed from Athens on February 14, 10 A.M., to M. Flammarion: "Éclat subit de β Ceti, supérieur à Aldébaran." M. F. Quénisset at Juvisy glimpsed the star on February 18, but mist prevented estimation of its magnitude. But on February 23 the sky in its neighbourhood was remarkably clear, and he could observe the star from 6 P.M. till 6^h 25^m when it disappeared behind a tree near the horizon. He saw it with the naked eye in spite of the bright twilight. *It was at least of the first magnitude* (italics in original). An exact measure was impossible so near the horizon. The magnitude in "connaissance des temps" is 2·24.

On the other hand, Mr. E. O. Tancock (B.A.A. Journ. No. 5) searched for the star by day in a clear sky on February 28 and March 3 without seeing it, though he could see Mira Ceti (estimated magnitude rather fainter than 2). Beta Ceti was lower down, but he considers that he would have seen it if it had still been of magnitude 1 on those days. His observations suggest that the increase of light was short-lived.

Vesta.—Vesta, the brightest of the asteroids, is now an easy object with binoculars, in the middle of the constellation Leo. It is due south at 10 o'clock at the beginning of April. The following ephemeris, by Mr. Bawtree, is from the B.A.A. Handbook for 1923:—

Greenwich Noon.	Mag.	R.A. h. m.	N. Decl.
April 9	6·60	10 43·2	19° 20′
,, 17	6·68	10 41·2	19° 11′
,, 25	6·77	10 41·2	18 49′

The British Astronomical Association is undertaking the work of providing ephemerides of the four brightest asteroids. The B.A.A. Journ. No. 5 contains an ephemeris of Pallas, but as this will be in a much better position for observation in two months, we defer giving its place.

Old Egyptian Water-clocks.—Several ancient time-observations, such as the statement of the equality of day and night at the equinoxes, make it clear that some form of clock was employed. It is therefore interesting to note that casts of two Egyptian water-clocks have lately been presented by the Egyptian Government to the Science Museum, South Kensington. One, from Karnak, dates from the reign of Amenhotep III. (B.C. 1415–1380); the other, from Edfu, is of the Ptolemaic Epoch; in the former, time is measured by the uniform escape of the water; in the latter, by its uniform admission. In each case there are twelve different scales, corresponding to the length of the night or day in different months. Each of these scales is divided into twelve equal parts, showing that an "hour" was at first of variable length, being one-twelfth of the length of the day or night at the particular time of year.

Claudius Ptolemy collected the observed times of the phases of a number of lunar eclipses; these were used by several investigators, including Newcomb, Cowell, and Fotheringham, in studies of the moon's secular acceleration. As the times were presumably observed with some such instruments as those now exhibited, their study is of some astronomical importance.

Research Items.

Early History of the Sioux Tribe.—In the Journal of the Washington Academy of Sciences (vol. xiii. No. 3), under the title of "New Light on Early History of the Siouan Peoples," Dr. J. R. Swanton produces new evidence, largely based on phonetics, of the former distribution of this race. He summarises the results of his inquiries as follows: "The occupancy of the territory of our Middle West between the great Lakes and the Ohio by Siouan tribes seems to rest on grounds almost historical. With the strong indications now at hand there seems reason to think that a close comparative study of the Siouan dialects would enable us to reconstruct the general outlines of their ancient geographical positions with considerable accuracy. If present indications are not deceptive, when that is done we shall find that they fell into four major linguistic groups: a north-eastern, consisting of the ancestors of the later Siouan tribes of Virginia, the Hidatsa, Dakota, Biloxi, and Ofo; a south-eastern, including most of the later Siouan peoples of the two Carolinas; a south-western, composed of the five tribes of Dorsey's Dhegiha group; and a north-western, Dorsey's Teiwere."

High-altitude Mountaineering.—Basing his conclusions on his experiences in climbing Mount Everest, Mr. G. I. Finch discusses the equipment for high-altitude mountaineering in the *Geographical Journal* for March. Up to 21,000 ft. the climber's physical functions were practically unimpaired and good sleep and recuperation from fatigue were possible, but at 23,000 ft. sleep was fitful, appetite fell off, and there was a general loss of physical fitness. The conclusion is that at, say, 22,000 ft. acclimatisation to altitude ceases and above that height oxygen should be used, at first in small doses, and from 26,500 ft. in larger doses, but the dose must depend on the nature of the ground. It must also be remembered that oxygen increases the appetite, and due provision must be made for this. The stimulating effect of cigarette smoke was noted at 25,500 ft. Although greater heights than these were reached without the use of oxygen, Mr. Finch thinks this procedure unwise, and believes that above the acclimatisation level a man must become steadily weaker and unable to recover from fatigue unless he makes use of oxygen. The article contains also some hints on clothing, footgear, and apparatus.

New Plants under Cultivation.—Part II. of Vol. 148 of *Curtis's Botanical Magazine* shows that figures and descriptions under the new editor, and conditions of publication, will maintain a high level. Among the plants described by Dr. Stapf, four are due to the activities of collectors in China; two new Rhododendrons, *R. sulfureum* Franch. and *R. planetum* Balf, a delightful Labiate from Yunnan named by Forrest *Dracocephalum Isabellæ*, and a small-fruited hardy apple *Malus toringoides* Hughes. Two orchids, *Maxillaria Fletcheriana* Rolfe and *Cirrhopetalum tripudians* Parish et Reichenb., two succulents, *Euphorbia anoplia* Stapf (S. Africa) and *Echinocactus undulatus* Dietr. (Mexico), two other African plants, *Amorphophallus coffeatus* Stapf and *Lachenalia convallariodora* Stapf, are described, together with one plant from the Afghan Indian frontier, *Lonicera Griffithii* Hook. f. and Thoms., a honeysuckle that seems to offer some difficulties in cultivation, although it has been grown in an unheated conservatory successfully and with very pleasing results.

British Cytospora.—In the *Kew Bulletin*, No. 1 for 1923, W. B. Grove has provided descriptions of the British species of Cytospora which will be of great value for mycologists, particularly for phytopathologists, as these fungi do considerable damage, especially among fruit trees. Cytospora is the name given to a conidial form, producing upon the branches of the host plant pustules and ultimately roundish discs, from the centre of which conidial discharge is indicated by a black point or little tendril of conidia held together by mucilage. When the full life-cycle can be traced, it will probably be found that all the species can be shown to be stages in the life-history of some Pyrenomycete, such as Valsa, Valsella or Eutypella. The necessary cultural experiments, to connect these conidial stages with their specific ascophorous form, should be carried out during the next few years in the cases where the host plants are cultivated plants of value. The British locality for a large number of the 62 species described is given as Kew Gardens, presumably because suspicious twigs are more frequently removed for expert examination from Kew than from trees that are less closely examined. Mr. Grove's list will, however, be an incentive to a more general study of the British species of Cytospora.

The Oldest Rocks of Maryland.—Following the general trend of opinion as research progresses among pre-Cambrian rocks, Eleanora B. Knopf and Anna T. Jones ("Stratigraphy of the crystalline schists of Pennsylvania and Maryland," *Amer. Journ. Sci.*, vol. 205, p. 40, January 1923) assign a sedimentary origin to the oldest known rocks of Maryland, which are styled the Baltimore gneiss. There is no tendency to revert to the old view that gneisses were deposited from primordial hot solutions. Their layer-structure represents normal sedimentary sheets, in which a complete recrystallisation of the constituents has taken place. Some dynamic metamorphism is traced in portions of the mass; but the principal feature of alteration appears to be due to invasion by a batholitic granite magma, with consequent *lit-par-lit* injection. This fact leads the authors to write of the composite rock as an "intrusive complex of early pre-Cambrian age," an expression that surely misrepresents the general conclusion at which their work arrives. The distribution of metamorphic masses in the local Palæozoic series is anomalous, and the presence of subjacent batholitic invaders is suggested.

A Great Stratigraphical Sequence.—The enormous vertical sections provided by the Grand Cañon of the Colorado River in Arizona remind one of the old-fashioned geological diagrams, in which the succession of known strata was represented as continuous at one spot and based inevitably on a floor of granite. Yet even the 4000 feet of horizontal beds exposed by the stream-cut at Bass Trail tell us nothing of what went on between Cambrian and Devonian times, and include, as Mr. L. F. Noble's detailed study shows, several notable if lesser unconformities. In Professional Paper 131B, United States Geological Survey (1922), Mr. Noble does not confine himself to the Bass Trail section, of which he gives a drawing worthy of reproduction as a lecture-diagram. He provides photographic studies of various unconformities, which the casual visitor would find it difficult to trace, and concludes with the suggestive outlier of Lower and Upper Triassic strata, forming the flat-topped Cedar Mountain, two miles from the cañon edge. His discovery in 1920 of the frond of *Callipteris conferta* in the Hermit Shale is regarded by Mr. White as definitely fixing the Permian age of that formation, which occurs 900 feet below the top bed of the Kaibab Limestone on the cañon rim. The author, despite the possibility of an unconformity at the base of the local Permian, uses the name Carboniferous rather than Permo-Carboniferous for the whole sequence, a course that seems unwise, in view of international usage. Fossils are, on the whole, rare in these splendid sections; but Pennsylvanian and Mississippian strata are both identified, above a small representative of Upper Devonian with Bothriolepis. The whole of the Gotlandian and Ordovician systems are unrepresented, and we pass down into undisturbed Upper Cambrian beds some 900 feet above the stream.

Ranger Oilfield, Texas.—The Ranger Oilfield is situated in the north-west of Eastland County, Texas, and is one of the most important latter-day developments of the great Mid-Continent Oilfield region of the United States. Oil was first struck here in 1917, beginning with the bringing in of the McClesky well at 2000 barrels per day. In 1918 the best wells had an initial production of 6000-7000 barrels of oil, and the total output for that year amounted to more than 6,000,000 barrels. In 1919 the wells collectively made more than 73,000 barrels of oil per day. Since that time a steady production has been maintained, though a noticeable decline is apparently manifest at the present time. The geology and structure of the field have recently been dealt with by Frank Reeves in Bulletin 736-E of the United States Geological Survey. Production is from nine oil-sands occurring in the Strawn Series, Smethwick Shale, and Marble Falls Limestone, all of Pennsylvanian age. The structure is that of very slightly inclined strata, the tilt forming part of the general monoclinal feature of the region as a whole. Locally, low pitching anticlines have been formed which have an important bearing on the accumulation of oil in the rocks involved. The oil obtained from the Ranger field is of a high quality, of mixed base, and has an average specific gravity of 0·84; it yields about 30 per cent. of petrol. It is to be regretted that the bulletin, describing as it does one of the most important oilfields of the south Mid-Continent, is not so well illustrated as many which embrace far less noteworthy properties; in particular the index map is almost unreadable. The large structure maps included at the back of the publication are, however, unusually clear and are of great educational value apart from real technical utility.

Meteorology of the South Atlantic.—Mr. H. H. Clayton makes reference in the U.S. *Monthly Weather Review* for November 1922 to a communication in the monthly bulletin of the Argentine Meteorological Office on the physical condition of the South Atlantic during summer by Mr. R. C. Mossman. The communication was to aid the relief ship sent by the Argentine Government each year to and fro between Buenos Aires and the South Orkneys to carry a party of new observers and to bring back the observers of the previous year from the most southern meteorological station in the world, which has been regularly maintained for the last twenty years. The period dealt with is comprised by December, January, and February. Charts prepared are said to show the position of the controlling high and low atmospheric pressures, and wind-roses are given for each 5° square and for each of the three months. Fog frequencies are stated to be shown for each wind direction. Allusion is especially made to the difference between a fog formed by a warm wind blowing over cold water and a fog produced by a cold wind over water at a higher temperature—the fog in the latter case extending to a much greater height, but the base not always reaching the earth's surface. The British Meteorological Office has thoroughly discussed the weather of the South Atlantic, extending to the South Orkneys, in a volume of monthly charts (M.O. No. 168) published twenty years ago.

The Roar of the Mountain.—A presidential address to the Washington Academy of Sciences was given on January 9 by Prof. W. J. Humphreys of the U.S. Weather Bureau, entitled "The Murmur of the Forest and the Roar of the Mountain," which is reproduced in Vol. 13, No. 4, of the Journal. Reference is made to historical instances recognised as of weather significance through past ages, and the roaring of the mountain is taken as an indication of a general storm within six to twelve hours. The particular region dealt with is the Gap Mills valley of Monroe County, West Virginia, but the discussion has common reference to mountain meteorology. It is shown how occasionally there are strong winds simultaneously up both sides of a high mountain ridge, and it is asserted that when there is an appreciable wind from the mountain there is often a lighter surface wind in the opposite direction up portions of the mountain itself. With tempest winds the conditions are said to be much like the Helm Wind along the west side of the Pennine range. Reference is made to the familiar singing or humming of telegraph or telephone wires. The tree and forest sounds are said not to be due to the elasticity of the twigs and branches but, as in the case of the singing telegraph wires, to the instability of the vortex sheets their obstruction introduces into the air as it rushes by them. The pitch of the æolian murmur of a forest is said to be essentially that of its average twig, and though the note of the twig may be inaudible at close quarters, the forest may often be heard miles away. Cloud and humidity are dealt with, as are also rain and snow.

A Luminescent Chemical Change.—An interesting example of luminescence occasioned by chemical change in solution, which is said to be more intense than the usual experiment involving the oxidation of pyrogallol, is described by W. V. Evans and R. T. Dufford in the February number of the Journal of the American Chemical Society. A solution of *p*-bromophenyl magnesium bromide in ether is prepared by the Grignard reaction between 2·4 grams of magnesium and 23·6 grams of *p*-dibromobenzene in 130 c.c. of dry ether, with a little iodine. The solution exhibits luminescence which can be observed in daylight when shaken in a test-tube in an atmosphere of oxygen. The luminescence spectrum lies between λ5200 and λ3500.

Innocuous Metol.—It is well known that metol, which is one of the most popular of photographic developers, suffers from the grave disadvantage that if it is allowed to come into contact with the hands it may cause persistent and exceedingly irritable sores. Mr. W. F. A. Ermen, of the British Dyestuffs Corporation, finds that almost certainly this is not due to metol itself. In a paper read before the Royal Photographic Society on March 20 (*British Journal of Photography*, March 23) Mr. Ermen gave details of the five principal methods for the manufacture of metol which the Corporation tried in 1916. A method of German origin, by the interaction of methylamine and hydroquinone, gave a very good preparation with extreme ease, but caused severe outbreaks of poisoning in both the laboratories and the works. This result was traced to the presence in the metol so prepared of the very soluble and extremely poisonous symmetrical dimethyl-paraphenylene-diamine. The metol prepared by the Lapworth process proved to be quite innocuous.

American Association Meeting at Boston.

THE seventy-sixth meeting of the American Association for the Advancement of Science was held at Boston on December 26-30. Several of the addresses delivered by presidents of sections have appeared in recent issues of *Science*, and brief accounts of some of them are subjoined.

Physics and Geometry.

In his address to Section A (Mathematics) Prof. Oswald Veblen discussed some of the aspects of postulational geometry in reference to the developments of physics during the last twenty years.

In the classical branches of physics the main elements of the abstract point of view have been implicit in them for a long time. When it is stated with sufficient clearness in physical terms what is meant by undefined elements, unproved propositions, and so on, it is often found that a physicist classifies these as truisms of little importance. So far as practical results are concerned he is justified in this attitude during the earlier and cruder stages of physical theory. But experience is showing that when the results of a more refined experimental technique force a reconsideration of fundamental assumptions, the technique of the study of these assumptions must undergo a corresponding refinement. A recent illustration is afforded by Einstein's theory of gravitation, which accounts for certain observed physical phenomena by casting aside the familiar conception of space and time in favour of a new one, which is just as self-consistent and capable of logical development.

Beginning with elementary geometry, the oldest branch of physics, there is a sequence of statements arranged in a certain logical order, but void of all physical meaning. In order to apply them to Nature, the undefined terms (points, lines, etc.) are identified as names of recognisable objects. The unproved propositions (axioms) are then given a meaning, and when this meaning can be identified with a true statement the theorems which are logical consequences are also true, and the abstract geometry takes its place as a useful branch of physics.

For kinematics it is necessary to have a theory of time: the undefined terms are "instant" and "before" or "after," and the postulates one of the sets of postulates for the linear continuum. The main theorem is that there is a continuous one-to-one correspondence between the instants of time and the numbers of a real number system.

Prof. Veblen has also formulated a set of postulates for "mass" or "substance," observing that the postulates proposed may contain both omissions and redundancies. They have merely been advanced to emphasise the fact that very little work has yet been done in this direction.

Allurements in Physics.

In his address to Section B (Physics) Prof. G. W. Stewart, of the University of Iowa, president of the section, dealt with the attractive nature of some of the problems of physics at the present time.

The investigation of atomic structure becomes so exciting that we may easily forget the absence of clearness in some of our hypotheses. The static theories have the advantage that they give clear pictures of the atoms which can be used in discussion of the physical and chemical properties of the elements as they appear in periodic groups and of the compounds they form. The orbital theories, on the other hand, have been most successful in explaining the spectra of hydrogen and helium, and, by the help of a further hypothesis, the spectra of the alkali metals. In his most recent work Bohr has departed from the simplicity of his original hypotheses and has endeavoured, by assuming electron orbits which may be circular, elliptical, or highly elliptical, and penetrate each other in many ways, to construct systems which would have the properties of the elements of the periodic table. Although this method of attacking the problem is not so rigorous, Prof. Stewart thinks it will prove more fruitful than that of the statical theories.

Acoustics receives little attention from physicists of the present day, but Prof. Stewart points out its allurements, and refers with keen appreciation to the work of the late Prof. W. C. Sabine of Harvard on the acoustics of buildings, which is only just becoming known in Great Britain. The problem of the best angle for a conical horn seems nearing solution and the conception of the instrument as a collector of sound replaced by the proper conception of it as a resonator.

Gas Ionisation and Resonance Potentials.

An address on this subject was given to Section C (Chemistry) by Prof. W. A. Noyes of the University of Chicago. The ionisation potential is the fall of potential through which an electron must move to acquire speed enough to drive out of an atom of a gas on which it impinges one of its outer electrons, known as valence electrons, and the resonance potential is the fall through which an electron must move to acquire speed enough to displace an electron of an atom from an inner to an outer ring of electrons. The two potentials should, according to the Bohr theory of the atom, be connected in a simple way with the spectrum of the gas, and many measurements have recently been made to test this theoretical conclusion. The agreement is not so satisfactory as one would desire, and there is considerable difficulty in interpreting the values of the potentials found in experiment in terms of changes in the atoms. Prof. Noyes thinks, however, that it is along these lines that our knowledge of atomic structure and of the mechanism of chemical combination will develop in the future.

Geology's Debt to the Mineral Industry.

Dr. Willet G. Miller, president of the Section E (Geology and Geography), selected as the subject of his presidential address, "Geology's Debt to the Mineral Industry." He explained that, throughout the history of its development, the progress of the science of geology has been helped to a large extent by work connected with the mineral industry. Werner and his disciples did much for the science of geology in its early development by their investigations of earth-structure as revealed in mines. William Smith, the English civil engineer, whose great work as the "father of geology" is so well known, established the principles of stratigraphical geology as a by-product of his work on engineering problems. He complained that the theory of geology was in possession of one class of men, the practice with another. Logan, the great pioneer of field studies in Canada, especially in the pre-Cambrian areas, declared that for many years he was engaged in coal-mining and copper-smelting, and that his connexion with geology related largely to its economic aspects.

After Logan's time little progress was made in pre-Cambrian studies in Canada until after the discovery of ore-bodies at Sudbury, Cobalt, and Porcupine in Ontario. Meanwhile, on the United States side of the border such advance as was made was the outcome of studies connected with extensive and important developments in the mining of iron ore and copper ore in that region. Indeed, both in its inception and throughout its history the prime motive underlying the work of the United States Geological Survey has been an economic one; and that Survey furnishes an excellent example of the valuable scientific work made possible only by the great utility of the organisation by which it was carried out. Other examples could be given, and Dr. Miller mentions particularly that of South Africa, where the science of geology profited immensely as a result of the establishment of diamond-mining and gold-mining industries.

Dr. Miller had no difficulty at all in showing that geology owes a great debt to the mineral industry. His address will be read with much interest by that ever-increasing band of workers who feel, as he feels, that science and art should be mutually helpful and not distrustful of one another, and that a genuine scientific worker does not necessarily sacrifice dignity by carrying out investigations the results of which are likely to be useful.

Structure and Origin of the Plant Gall.

Prof. Melville T. Cook devoted his address, as president of Section G (Botany), to the subject of plant galls, and thus rendered a service to the workers in a field where literature is very scattered. In America, as in Europe, this study has been shared between entomologists, bacteriologists, mycologists, and other students of plants, and a general comprehensive account is difficult to find; from this address it appears that there is still much work to be done, progress probably having been delayed by the specialist angle from which each investigator has approached the problem.

The old idea that the gall arose as the result of a special fluid excreted by the insect as it punctured the plant has long been discredited; but although it is known that the gall tissue develops *pari passu* with the growth of the larva from the deposited egg, there is very little information as to how the larva reacts upon the plant tissue and whether the effect is produced by mechanical or chemical agencies. The reaction evidently depends in part upon the plant tissue affected, and Prof. Cook lays great stress upon the fact that it is usually only meristematic tissue which is stimulated to abnormal growth; but bearing in mind the conditions under which cork meristem arises in the plant as the result of a wound, it seems probable that in a living tissue the capacity for meristematic activity will usually be found in the proximity of the potential gall-former.

Küster, in 1911, divided gall tissues into abnormal growths, consisting only of parenchyma, the kataplasmas, and growths undergoing further differentiation of tissue, the prosoplasmas. Prof. Cook, and also Wells, have developed this original classification indicating that the more highly developed prosoplasm is a more specialised form of growth which has had its "kataplasmic" stage; the most complex types, such as the Cynipid galls, actually showing differentiation into four zones arranged concentrically around the larval irritant. Galls of fungoid or bacterial origin are also discussed in the light of this description of types of insect galls, and it will interest British botanists to find that Prof. Cook has evidently an open mind as to the analogy drawn by Dr. Erwin F. Smith between the crown gall caused by *Bacterium tumefaciens* and the malignant growths found in the animal. He is evidently inclined to regard Dr. Smith's "embryomas," arising at a distance from the original infection, as due to the disturbance of normal functional activity in the host, just as in the case of the formation of aerial tubers upon the potato as the result of the attack of *Rhizoctonia Solani*.

The Mining Industry of Canada.

Dr. J. B. Tyrrell selected the history of Canadian mining for the subject of his presidential address to Section M (Engineering). In such an address the details of so wide a subject cannot of course be dealt with, but Dr. Tyrrell gave a very clear outline of the general course of progress of the Canadian mining industry. Necessarily, in so doing he has included much interesting information on the development of Canadian metallurgy, for it is impossible to separate these two arts when tracing the history of either in any particular new country, any more than they can be divorced when considering the early history of human civilisation as a whole.

The records of Canadian mining commence as early as 1576 with Frobisher's attempt to find gold on the shores of the bay that now bears his name. Better success attended later efforts to work the commoner minerals, and the history of true mining in Canada may be said to date from the discovery of coal near Sydney, Cape Breton, in 1672, which laid the foundation of the important coal-mining industry and perhaps even more important iron and steel manufacture of the Maritime Provinces. Dr. Tyrrell chronicles the discovery of bog iron ore in the province of Quebec about the middle of the 17th century, and the erection of a blast furnace to smelt this ore in 1737. So far as iron is concerned, the history stops with the erection of charcoal furnaces in Ontario in 1810, followed by another in 1813 in Norfolk County, which remained in blast until 1847. It is to be regretted that Dr. Tyrrell did not carry this particular industry somewhat further. An interesting chapter would be furnished, for example, by the attempts to utilise the iron sands along the north shore of the St. Lawrence: these were discovered in 1767, when a Mr. Molson of Montreal built forges of the Catalan type to smelt them; but his enterprise was commercially unsuccessful though he made good iron, and it closed down after a life of nine years. The same fate attended attempts made afterwards by others, among whom was Dr. Sterry Hunt. A charcoal blast furnace was erected early in the 19th century at Londonderry, Nova Scotia, where a brand of pig-iron, which at one time had a great reputation under the name of Acadian pig-iron, was smelted from ores consisting chiefly of brown hæmatite and ankerite. At this place the first coke blast furnace in Canada was built about 1876 by the Steel Company of Canada, Ltd. Afterwards attempts were made to utilise the interesting fossil ore of Nictaux in the Annapolis Valley, Nova Scotia, but now the important iron industry of this province relies upon the magnificent Wabana ore brought across from Newfoundland.

Dr. Tyrrell describes well and clearly the modern developments in Canadian mining, which he dates from the construction of the Canadian Pacific Railway in 1885, and shows good grounds for his conclusion that in mining "our country offers a field for extensive and intensive research second to none in the world," though he justly emphasises the need for a thorough scientific training for those who are to take the lead in future developments.

Experimental Production of Green and Colourless Hydra.

W. GOETSCH, of Munich, has carried out a series of experiments on Hydra, and has published the results in some half-dozen short papers, two of which form the subject of this notice (*Die Naturwissenschaften*, pp. 202-205, 867-871, 1922). Specimens of Hydra are either green, brown, or grey, and these are regarded by most authors as belonging to distinct species or even genera, though in certain cases the brown and grey are difficult to distinguish. Goetsch points out that the brown and green may also be difficult to distinguish, for some of the former can take green algæ into their endoderm cells and form a symbiotic union similar to that long known in green Hydra.

Goetsch obtained from a warmed tank in the Botanic Garden in Nymphenburg some brown Hydra which showed pathological features, and when he fed these with algæ they developed a green colour first around the mouth, then in the foot region, and finally in the intervening portion, so that in about a fortnight the entire animal had an intense green colour. The spread of the algæ was accompanied by a progressive diminution in the size of the Hydras so that they had difficulty in capturing their prey, the reserve material of the interstitial cells degenerated, and budding ceased. These green examples disappeared from the aquarium, but a few which remained in culture vessels were fed with freshly killed Daphnia and were thus carried through their abnormal condition. The reciprocal toleration between the Hydra and the alga soon becomes an intimate association. Afterwards these Hydra produced buds containing the green algæ, and some of them showed ovaries or testes—apparently two were males and two were females.

It is impossible to determine whether the specimens are *H. attenuata* or *H. vulgaris*. The alga in these green specimens is (as in the true green Chlorohydra) a Chlorella, but differs from that in Chlorohydra in being twice as large, and in being situated in the distal end of the endoderm cells, whereas in Chlorohydra the algæ are near the base of the endoderm cells. These green examples differ further from Chlorohydra in that the symbiosis is easily lost; if the green specimens are kept in the dark or cold the green colour disappears with the exception of a small amount around the base of the tentacles, but on transferring the specimens to better conditions the algæ begin to multiply again. Specimens kept four weeks in darkness lost every trace of their algæ; the only way to make these green again was to introduce into them fresh algæ contained in crushed pieces of green specimens enclosed in the carapace of a Daphnia.

Goetsch suggests that this brown Hydra is a new mutant, and that with the origin of this mutant capable of receiving the algæ in the warm house in the Botanic Garden the conditions were for the first time favourable for the institution of the symbiosis. This union cannot be maintained through the cold of winter, and is not transmitted through the egg. In Nature the Hydras would probably not have come through the first attack by the algæ, for those in the cultures owed their survival to artificial help. If a brown and a green specimen of the same species be cut into two and a brown piece and a green piece be joined together by means of a hair, there is a gradual extension of the algæ into the previously uninfected part.

The problem of the production of colourless specimens from the green Chlorohydra has also been attacked by Goetsch. Colourless examples were obtained by Whitney by placing Chlorohydra in weak glycerine, which caused the endoderm cells to expel their algæ. Hadzi kept Chlorohydra in the dark and they produced eggs without algæ, and he thus obtained alga-free examples one of which was reared. Goetsch kept Chlorohydra under unfavourable conditions—cold, darkness, and lack of calcium—to suppress the growth of the algæ, and then liberally fed the Hydra so that their cells multiplied so quickly that the algæ could not keep pace. After a few weeks of such treatment the buds produced were of a paler colour, especially in the middle region of the body. As this is the region where asexual reproduction takes place, offspring were eventually obtained free from algæ. These whitish specimens are more feeble than green examples, and require careful treatment. A spontaneous return of colour in these white specimens has not occurred, although some of them have lived for four months in the light.

Deep green and colourless pieces were joined together and the spread of the green algæ was studied. Algæ thrust out of the endoderm cells of the green part are taken up with other food by the endoderm cells of the other part, so that after a few days the whitish part begins to exhibit a green colour, even at places distant from the junction. If a bud is formed at the junction of the two pieces it may be half green and half white. Such a bud affords strong evidence against the purely ectodermal origin of buds.

University and Educational Intelligence.

Aberdeen.—At the spring graduation held on March 28, Sir George Adam Smith, the vice-chancellor, presiding, the degree of LL.D., *honoris causa*, was conferred on Sir William H. Beveridge, director of the London School of Economics; Dr. E. W. Hobson, Sadleirian professor of pure mathematics, University of Cambridge; Dr. W. Mackie, of Elgin, distinguished by his researches on the geology of the north-east of Scotland; Sir George H. Makin, consulting surgeon to St. Thomas's Hospital; and Prof. C. Niven, emeritus-professor of natural philosophy, University of Aberdeen.

The degree of Doctor of Science (D.Sc.) has been conferred on Dr. J. L. Rosedale for a thesis—"On the Hydrolysis of the Proteins of Flesh."

The Senatus Academicus has appointed Prof. Matthew Hay to represent the University at the Pasteur centenary celebrations to be held in Paris and Strasbourg in May.

Prof. Kruyt, Utrecht University, will deliver a university lecture in the faculty of science on May 11.

Durham.—Prof. H. Louis, at present professor of mining and surveying, and William Cochrane lecturer in metallurgy at Armstrong College, will vacate his appointments on September 30, 1923, on reaching the retiring age. Prof. G. Poole, of the University of Leeds, has been appointed as professor of mining. This appointment was made by the council on the recommendation of a joint committee of the College and the Durham and Northumberland Coal Trades Association. Dr. J. A. Smythe, at present senior lecturer in chemistry, will take over the William Cochrane lectureship in metallurgy; other arrangements are being made in connexion with the surveying teaching, formerly under the supervision of Prof. Louis.

Prof. R. F. A. Hoernlé, professor of philosophy, has now left England to take up his appointment as professor of philosophy in the University of Johannesburg. The council of Armstrong College will proceed to the appointment of a successor to take up office in October.

Prof. G. H. Thomson, professor of education, and joint author with Dr. William Brown of the "Essentials of Mental Measurement," has been invited by the Teachers' College, Columbia University, New York, to spend next academic year there, delivering advanced courses on psychology. The council of Armstrong College has granted him a year's leave for this purpose.

LONDON.—Presentation Day will be held in the Royal Albert Hall, on Thursday, May 3.

The degree of D.Sc. in biochemistry has been conferred on Miss K. H. Coward, an internal student, of University College, for a thesis entitled "The Formation of Vitamin A in Plant Tissues."

Applications are invited for the Astor chair of pure mathematics tenable at University College, in succession to Prof. M. J. M. Hill, retired. The latest date for the receipt of applications, by the Academic Registrar, University of London, South Kensington, S.W.7 (12 from each candidate) is May 24.

MANCHESTER.—The trustees of the Dickinson scholarships, open to medical students and graduates of the University, have announced the conditions and regulations. The scholarships are as follows: (i.) research travelling scholarship in medicine, of the value of 300*l*. for one year, awarded annually; the scholar is required to spend at least ten months abroad and undertake there original investigation; (ii.) anatomy scholarship (25*l*. for one year), to be awarded to the most distinguished first-year anatomy student; (iii.) surgery scholarship (75*l*. for one year, offered in alternate years to a scholarship in pathology), open to medical graduates of the University; the scholar must devote himself to original investigation; and (iv.) pathology scholarship (75*l*. for one year), on the same lines as the surgery scholarship. Full particulars are to be obtained from Mr. Frank G. Hazell, Secretary to the Dickinson Trustees, The Royal Infirmary, Manchester.

OXFORD.—A fund amounting to nearly 2000*l*. has been raised to provide a memorial of the late Sir William Osler, Regius professor of medicine. It has been decided to place a memorial bronze plaque in the University Museum, and to award a medal every five years to a graduate of the University who has made some distinguished contribution to medical science. It is also desired to provide a fund to assist teachers in the University to travel for purposes connected with medical knowledge and research. For this latter object further contributions are required; these should be sent to Mr. A. P. Dodds-Parker, 2 Holywell, Oxford.

The professor of pathology, Dr. G. Dreyer, has been appointed to represent the University at the forthcoming celebration at Paris and Strasbourg of the centenary of the birth of Pasteur.

Mr. M. E. Shaw, of New College, has been elected Radcliffe travelling fellow. The Radcliffe prize has been awarded to Dr. A. D. Gardner, University College, sometime Radcliffe travelling fellow.

The Matteucci gold medal, conferred as a posthumous honour by the International Research Council at Brussels in 1919 on the late Mr. H. G. Moseley, of Trinity College, has been received at Oxford and delivered to his mother, Mrs. Sollas.

The governing body of Exeter College will hold an election in the summer term to a research fellowship of 200*l*. a year, free of income tax, tenable for 5 years. Candidates, who must be members of the University of Oxford of at least B.A. standing, must send in applications by May 15 to the rector, who will supply further details.

Societies and Academies.

LONDON.

Geological Society, February 16.—Prof. A. C. Seward, president, in the chair.—A. C. **Seward**: The earlier records of plant-life (presidential address). Reference was made to the views of Dr. Church on the origin of life in the waters of a primeval world-ocean, and on the origin of terrestrial vegetation from highly-organised Algæ transferred by emergence of portions of the earth's crust above the surface of the water. The vegetation of the land may have received additions from upraised portions of the crust at more than one epoch in the history of the earth. The course of evolution is probably more correctly illustrated by the conception of separate lines of development, than by that of a branching tree implying the common origin of the main groups of plants. The unfolding of plant-life must be considered in relation to the changing geological background. Diffusion-phenomena, as illustrated by the so-called Liesegang figures, possibly explain the origin of some of the structures which are usually attributed to organic agency. We have no knowledge of any Pre-Cambrian land-flora. The phyla of Lycopods and Ferns are regarded as independently-evolved groups. The wide geographical range of Archæopteris was emphasised, and reference was made to the difficult problems raised by the occurrence of Upper Devonian floras well within the Arctic circle, at least equal (in the variety of the plants and in the vigorous development of the vegetation) to the more southern floras of Ireland, Belgium, and other regions.

March 14.—Prof. A. C. Seward, president, in the chair.—E. M. **Anderson**: The geology of the schists of the Schichallion district of Perthshire. Between Carn Mairg and Schichallion the succession is:—graphite-schist: pebbly quartzite: mica-schist: non-pebbly quartzite: schichallion boulder-bed. Following the boulder-bed, and thus on the same side of the quartzite, are a white limestone, a banded series of siliceous and micaceous rocks, a grey carbonaceous limestone, and a slightly carbonaceous mica-schist, which may be named the grey schist. On approach to the white limestone the boulder-bed becomes highly calcareous. This conglomerate is probably a tillite, and has been partly formed from the material of the limestone. There may thus be a chronological sequence, of which the oldest visible member is the grey schist, extending upwards to the Ben Ledi grits in an adjoining part of Perthshire. In the northern part of the Schichallion district the Dalradian series is bordered by the Struan flags. The junction is probably not an unconformity, but either a normal fault which has been affected by strong horizontal movement, or else a folded thrust.—H. H. **Read**: The petrology of the Arnage district in Aberdeenshire: a study of assimilation. The modification of magmas by the incorporation of material of sedimentary origin is here termed contamination. In the Arnage mass in Aberdeenshire the sediments concerned in contamination are: (*a*) andalusite-schists and pebbly grits of the Fyvie series; and (*b*) biotite-schists and subordinate hornblende-schists of the Ellon series. The contaminated rocks occur as a roof-zone, some hundreds of feet thick, overlying a sheet of norite rich in magnesia, and are of four types. Assuming that the initial magma was normal gabbro, the contamination-process depends on reciprocal reaction between initial magma and xenoliths, whereby the magma loses magnesia and lime and becomes richer in alumina and alkalies, the final results of the reciprocal reaction being the granitic Ardlethen type of contaminated rock and certain xenoliths extremely rich in magnesia and lime. The modified xenoliths sink in the acidified magma of the contaminated zone; they pass into the underlying sheet of initial gabbro, which becomes enriched in magnesia and lime, with the formation of the norite now seen beneath the contaminated zone. The chemical variation in the contamination-process is exactly the same as that in igneous rocks as a whole. Reciprocal reaction may play a part in magmatic differentiation, especially in the great gabbro-sheets.

Mineralogical Society, March 13.—Dr. A. Hutchinson, president, in the chair.—A. **Hutchinson**: A graphical method of correcting specific gravity determinations. A diagram is given by which the correction for air displacement and reduction to 4° C. can be read off directly.—A. **Brammall** and H. F. **Harwood**: The Dartmoor granite (Widecombe area). Field evidence and analyses support the conclusion that the granite is a composite laccolite and that four successive stages of intrusion are recorded by (1) dark and relatively basic granites scantily exposed and by certain cognate xenoliths resembling basic segregations; (2) a more acid granite which caps many tors and yields mineral evidence of having assimilated country rock; (3) a still more acid granite intrusive into the latter; (4) minor acid intrusions. Felspars, garnet, cordierite, etc. are described, and evidence for differentiation is given.—C. E. **Tilley**: Genesis of rhombic pyroxene in thermal metamorphism; mineral associations and the phase rule. Free-silica hypersthene-bearing hornfelses of sedimentary origin can be divided into a calcic and non-calcic group, and considered as derived from a normal shale hornfels by increments either of CaO, (MgO + FeO), or less commonly K_2O. Silica-poor hypersthene hornfelses can be derived from the free-silica types, and the hypersthene is then frequently accompanied by spinel. The derivation of all these hornfelses can be graphically expressed in systems of three or four components. The hypersthene is derived from the chlorite in the original sedimentary rocks subjected to metamorphism. Hypersthene arises when enstatite, augite, or amphibole-bearing igneous rocks enter contact aureoles. Rhombic pyroxene is produced by contamination of gabbroic rocks.—C. S. **Garnett**: (1) On a peculiar chlorite-rock at Ible, Derbyshire. A band in the dolerite sill at Ible is completely altered to a foliated mass of chlorite, with associated veins of fibrous chlorite (resembling chrysotile in appearance). The analyses and characters of this material are compared with those of "epichlorite." (2) The dissociation of dolomite. Dissociation is inappreciable up to 625°, and at 898° it is complete. The temperature-dissociation curve is continuous.—J. G. C. **Leech**: Occurrences of rutile, brookite, and anatase in the St. Austell granite. These minerals occur in the red pneumatolysed granites of the area, the mode of occurrence being essentially the same as that recorded for Dartmoor occurrences of these minerals.

Linnean Society, March 15.—Dr. A. Smith Woodward, president, in the chair.—J. **Parkin**: The strobilus theory of Angiospermous descent. The idea that the flower has evolved by reduction from a bisexual cone of a special type is elaborated. This Anthostrobilus is characterised by having the microsporophylls borne on the axis invariably below the megasporophylls; it is peculiar to the Angiosperms, Bennettitales, and Gnetales. From the Pteridosperms, strobilate plants arose either (1) by the segregation of the two kinds of sporophylls into unisexual cones, or (2) by their aggregation into one and the same cone. The Anthostrobilus may have been called into being through the substitution of insect-pollination for wind-pollination. The Angiosperms are regarded as a monophyletic group and the Monocotyledons as of monophyletic origin from the Dicotyledons and of Ranalian extraction. The 8-nucleate sac is taken as primitive for Angiosperms. A return to the Ranales as the starting-point for the evolutionary study of the flower is advocated.

Aristotelian Society, March 19.—Prof. A. N. Whitehead, president, in the chair.—Miss H. D. **Oakeley**: Prof. Wildon Carr's Theory of Monads. The importance as well as the difficulties of this theory lie in its attempt to combine into a unity the points of view of idealism and of creative evolution. The means by which the two viewpoints are brought into unity is the concept of reality as activity. The theory raises complex and many-sided problems in regard to a monad's knowledge, the nature of the material world, inter-monadic intercourse and the ultimate reality within or beyond experience. The problem of knowledge is conceived by Prof. Carr from the point of view of relativity and the doctrine of perspectives. The material universe results from the dichotomy of experience essential to activity, for activity can be conceived only as an opposition of antithetical forces. "Activity" is the core of the metaphysical theory. It is the reality of the monad, and its first expression is the æsthetic creative production of images. The doctrine of the monadic nature of reality is based on intuition, but Prof. Carr claims that modern science confirms his view, arguing that science must postulate that monads constitute the real, in order to make its results fully intelligible. Knowledge according to the theory must be perspective in form, and this also is supported by arguments from modern scientific relativity.

Royal Microscopical Society, March 21.—Prof. F. J. Cheshire, president, in the chair.—M. T. **Denne**: An improved apparatus for the production of photomicrographs. The apparatus consists of a bed made up of two heavy rectangular metal bars, upon which slides a carriage, one end of which is shaped to act as support for the microscope lens system, a separate microscope not being used. The carriage also bears one end of the camera bellows, and an optical bench for the below-stage apparatus. The head of the camera with dark slide fitting is fixed at one extremity of the bed itself. The eyepiece of the microscope is brought through the orifice of the plate-holder fitting, when adjustments may be made, the camera bellows being collapsed over the body of the microscope. For metallurgical work the usual vertical illuminator is employed with a right-angle prism arranged above the main optical axis. The apparatus is compact, although giving 800 mm. camera extension, and, since it is not necessary to swing the microscope out of the axis for preliminary adjustments, difficulties due to decentralisation are eliminated.—A. C. **Thaysen** and H. J. **Bunker**: The destruction of cellulose fibres and fabrics by micro-organisms and the importance of the microscope in the study of this destruction. Destruction of fibres such as cotton and flax involves vast sums of money; the United States Department of Agriculture place the annual damage to American cotton, on this account, at seventy million dollars. Different types of cotton are differently affected. All true Indian cottons appear to deteriorate quickly, at a rate which is constant. American cottons are far more resistant, but they also show a constancy in their rate of deterioration. The greater resistance of American cottons appears to be due to at least two factors: the absence of food, and some more positive factor. This latter appears to be affected by climatic conditions, since American cottons grown in India show, on the addition of food material, an accelerated rate of deterioration. Selective breeding might possibly assist in the isolation of strains of cotton resistant to bacterial attack.—E. **Hatschek**: The standard methods of ultra-microscopy. The methods of making visible those particles small compared with the wave-length of light (100 $\mu\mu$ and less) fall into two classes: (1) illumination at right angles to the axis of the microscope (Zsigmondy-Siedentopff ultra-microscope and Jentzsch ultra-condenser), and (2) axial illumination so arranged that direct light is totally reflected at the cover glass (dark ground condensers, *e.g.* paraboloid, cardioid, concentric, etc.). The performance of the slit ultra-microscope was discussed.

Royal Meteorological Society, March 21.—Dr. C. Chree, president, in the chair.—G. M. B. **Dobson**: Characteristics of the atmosphere up to 200 km., as obtained from observations of meteors. The rate of heating and evaporation of a meteor depends on the air density. Nearly all the kinetic energy of the meteor is finally radiated as visible light, and thus observations of a meteor's total brightness and velocity give its mass. Hence from the observed characteristics of meteors it is possible to calculate the density of the air at the height of their appearance and disappearance. The rate of change of density with height will indicate the air temperature. From eye observations of meteors the temperature of the air is about 220° a. (−63° F.) up to 50 km., thus agreeing with the results of *ballon sondes*. Above 60 km. the temperature is about 300° a. (81° F.), and the density at 100 km. is about 100 times greater than that usually calculated on the assumption of a uniform temperature of 220° a. The high temperature is presumably due to the absorption of solar radiation by the air in addition to terrestrial and atmospheric radiation, due possibly to the presence of ozone formed at great heights by the sun's ultra-violet light. There is indirect evidence of an annual variation of air temperature.

Dublin.

Royal Dublin Society, February 27.—Prof. J. A. Scott in the chair.—P. A. **Murphy**: On the cause of rolling in potato foliage; and on some further insect carriers of the leaf-roll disease. The mechanism of rolling of potato foliage as caused by leaf-roll, and incidentally by some other diseases and injuries, is discussed. The cause of rolling in the cases investigated is the distension of the spongy parenchyma following the accumulation of carbohydrate in the leaves. The activities of a capsid (*Calocoris bipunctatus*), a jassid (*Typhlocyba ulmi*), and an aphis (*Myzus Persicæ*) which develops on the sprouts of unplanted tubers, in carrying leaf-roll are discussed. —John J. **Dowling**: The recording ultramicrometer: its theory and applications. The theoretical principles of the device, together with a description of some experimental investigations into the conditions of operation, are discussed. The degree of sensitivity attained under ordinary laboratory conditions is 10^{-7} cm.; this being strictly reproducible and the apparatus quite easy to operate. The operation of the apparatus at still higher sensitivities requires special precautions, such as screening and the like.

March 27.—Prof. J. A. Scott in the chair.—R. L. **Praeger**: Catalogue of scientific and technical periodicals in Dublin libraries. A card-index catalogue showing all the scientific periodicals available in Dublin has been prepared by a special committee. In each case the extent of the sets in each library is shown, together with any breaks which occur. Thus it is possible to ascertain if any number of any periodical, whether current or extinct, is available in Dublin, and where it is to be found. It is proposed to endeavour to improve the supply of such literature by suggesting the discontinuance of some periodicals which are unnecessarily reduplicated and their replacement by others at present unavailable.—W. R. G. **Atkins**: The hydrogen ion concentration of the soil in relation to the flower colour of *Hydrangea hortensis* W., and the availability of iron. The hydrangea produces blue flowers when grown in acid soil, since iron salts are absorbed in larger amounts and react with the pink flower pigment. Iron is absorbed by plants mainly in the ferrous condition, for at ordinary soil P_H values ferric iron is completely precipitated. Ferrous salts are not completely precipitated at $P_H 7$. The lessened solubility in alkaline soils is considered in relation to chlorosis. Iron pan formation is connected with the oxidation of the ferrous hydroxide precipitated when acid soil solution percolates to a region of higher P_H value.—H. G. **Becker** and E. F. **Pearson**: Irregularities in the rate of solution of oxygen by water. A form of apparatus is described which permits the process of absorption to be observed continuously by means of a sensitive water manometer, the temperature being maintained constant to 0·1° C. The results obtained show that during the early stages, absorption follows a logarithmic curve very closely, but after the gas-content has risen to about 70 per cent. of saturation the absorption tends to become irregular. This indicates that the force producing the slow mixing during the early stages tends to become very small, and therefore uncertain in its action towards saturation.

Paris.

Academy of Sciences, March 12.—M. Albin Haller in the chair.—Luigi **Bianchi**: A kinematic property of W surfaces.—M. Jules Bordet was elected a foreign associate in succession to the late M. Ciamician, and M. J. Cornet corresponding member of the section of mineralogy in succession to M. W. C. Brögger, elected foreign associate.—**Mordoukhay-Boltovskoy**: The logarithm of an algebraic number.—M. **Hadamard**: Remarks on the preceding communication.—M. **Mandelbrojt**: Taylor's series with gaps.—M. **Malaval**: Hardening (of metals). Metals can be hardened not only by longitudinal extension (Seigle) but also by compression, and the latter method was applied in 1912 to a gun, with good results.—Georges **Darmois**: The local integration of Einstein's equations (interior problem).—M. **Cisotti**: Plane movements of liquids endowed with viscosity.—D. **Eginitis**: The reform of the calendar in Greece. A discussion of the political and ecclesiastical difficulties attending the reform of the calendar in Greece.—M. **de Broglie** and E. **Friedel**: The diffraction of the X-rays by smectic bodies. The smectic state is defined as one in which the molecules, having a common direction, are distributed along parallel equidistant surfaces. Such substances should act on X-rays like the system of parallel reticular planes of a crystal. In confirmation of these views experiments on the diffraction of X-rays by solutions of sodium oleate are described. Combined with the experimental figures of P. V. Wells, these results form the first direct measurement of the wave length of the X-rays starting with optical wave lengths, and without making use of either Avogadro's constant or Planck's constant.—J. **Cabrera**: The limits of K absorption of some elements. Results are given for a group of sixteen elements, mainly from the rare earths.—M. **Volmar**:

The photolysis of tartaric acid and the acid alcohols. Solutions of tartaric acid exposed to ultraviolet light give off gas containing carbon dioxide (66 per cent.), carbon monoxide (10 per cent.), hydrogen (21 per cent.), and hydrocarbons. The solution contains an aldehyde and small quantities of a substance resembling the hexoses.—Pierre **Steiner**: The ultraviolet absorption spectrum of veratrol and vanillin. The absorption curve of veratrol resembles that of pyrocatechol: the introduction of two methyl groups into the pyrocatechol molecule has only a slight influence on the spectrum.—Victor **Henri** and E. **Walter**: The law of the distribution of the bands in the ultraviolet absorption spectrum of the vapour of toluene.—Armand **Castille** and F. W. **Klingstedt**: The ultraviolet absorption spectra of benzoic acid and of the three oxybenzoic acids. The ortho- and meta-oxybenzoic acids give nearly the same spectrum, but the para acid shows marked differences in the number and appearance of the absorption bands.—M. **Bourguel**: The preparation of true acetylenic hydrocarbons. Sodium amide removes hydrobromic acid from many brominated hydrocarbons. The reaction can be followed by titrating the ammonia evolved; the yields are good, and there is no tendency to polymerisation of the acetylene derivative.—M. **Lespieau**: The dinitrile of β-oxyglutaric acid, $CN . CH_2 . CH(OH) . CH_2 . CN$.—P. **Diénert**: Subterranean circulation of water in fissured ground.—M. **Solignac**: The tectonic of the country of the Mogods, the plateau of Hédil and of northern Bejaoua (Northern Tunis).—E. **Bauer** and A. **Danjon**: Atmospheric absorption on Mont Blanc.—Jean **Dybowski**: A new industrial force: the utilisation of the heat furnished by thermal springs. A suggestion that the hot water from thermal springs might be utilised for forcing fruit and plants under glass.—P. **Bugnon**: The number of cotyledons of Ficaria. *Ficaria ranunculoides* has been regarded by different authors as containing two, one, or no cotyledons, and the true number has an important bearing on the theory of the origin of the monocotyledons. Ficaria possesses two leaf organs having the same anatomical connexions with the root as the two cotyledons of the dicotyledonous species of the same family: the most plausible hypothesis is that Ficaria is heterocotyledonous.—Marcel **Mirande**: The nature of the secretion of the sterinoplasts of the white lily. The central body of the sterinoplasts is a lipoid solution of phytosterol.—M. **Trabut**: Carpoxeny and bud mutation in cultivated Citrus.—J. **Feytaud**: A plan of campaign against the Doryphore of the potato.—A. **Demolon** and P. **Boischot**: Researches on the assimilability of phosphatic manures. A saturated solution of carbon dioxide was used to dissolve the soluble phosphate, and special attention was given to the effect of the presence of calcium carbonate on the amounts of phosphorus extracted from various types of phosphatic manure.—H. **Hérissey**: The reversibility of the ferment action of α-*d*-mannosidase.—Marcel **Baudouin**: Radiography applied to the study of the lesions of prehistoric human bones. Human remains of the polished stone age have been submitted to radiographic examination with interesting results. Fractures in bones have been detected, certain congenital lesions identified, also a case of chronic osteoarthritis, and two traumatisms due to foreign bodies, one of which is undoubtedly a sharpened flint.—André **Broca** and Jean **Comandon**: The representation of movement in pictures.—Jacques **Pellegrin**: New contribution to the ichthyological fauna of the fresh waters of Morocco.—H. **Bordier**: The influence of diathermic d'Arsonvalisation on the endocrinic glands. Application to the treatment of Basedow's disease. This method of treatment, of which the technique is described, has been applied with success to several cases of exophthalmic goitre.

Diary of Societies.

SATURDAY, April 7.

Gilbert White Fellowship (Annual General Meeting) (at 6 Queen Square, W.C.1), at 2.—Sir David Prain: Presidential Address.

MONDAY, April 9.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—A. Hiorth: Irrigation of Palestine.
Royal Institution of Great Britain, at 5.—General Meeting.
Society of Engineers, Inc. (at Geological Society), at 5.30.—T. Exley-Fisher: The Work of the Labour Corps in France during the War, with Particular Reference to the 178 Labour Company.
Royal Institute of British Architects, at 8.—H. M. Fletcher: The Architecture of Provincial France.
Aristotelian Society (at University of London Club), at 8.—Prof. C. D. Broad: The Natural Meaning of the Unconscious.
Royal Society of Arts, at 8.—E. Kilburn Scott: The Fixation of Nitrogen (1) (Cantor Lectures).
Society of Chemical Industry (London Section) (at Engineers' Club, 39 Coventry Street), at 8.—S. S. Zilva and J. C. Drummond: The Cod Liver Oil Industry of Newfoundland.—E. W. Blair, T. S. Wheeler, and J. Reilly: A Study of the Separation of the Gases formed in the N-butyl-alcohol-acetone Fermentation Process.
Royal Geographical Society (at Æolian Hall), at 8.30.—P. Bigelow: Geographical Influences bearing upon Japan and her Neighbours.
Institution of Rubber Industry (at Engineers' Club, Coventry Street).—Dr. D. F. Twiss: Rubber Pigments.

TUESDAY, April 10.

Royal Institution of Great Britain, at 3.—Sir Arthur Keith: The Machinery of Human Evolution (1). Nature of the Machinery.
Society for the Study of Inebriety (at Medical Society of London), at 4.—Dr. W. M. Feldman and others: Discussion on Racial Aspects of Alcoholism.
Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.—A. E. Chambers: Potrero No. 4. A History of One of Mexico's Earliest and Largest Wells.
Zoological Society of London, at 5.30.—Dr. G. M. Vevers: Notes on a Recent Visit to Zoological Gardens in Holland and Belgium.—Prof. K. Kostanecki: A Remnant of the Omphalo-mesenteric Arteries in the Manatee.—Dr. C. F. Sonntag: The Anatomy, Physiology, and Pathology of the Chimpanzee.
Institution of Civil Engineers, at 6.—A. Binns: The King George V. Dock, London.
Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—H. M. Cartwright: Study of Bichromated Gelatine with reference to Photogravure.—W. Clark: The Reduction Centres of a Silver Bromide Emulsion.
Röntgen Society (at Institution of Electrical Engineers), at 8.15.—M. A. Codd: A New Method of Operating Induction Coils.

WEDNESDAY, April 11.

Royal Society of Arts, at 4.30.—E. Parnell: The Resources and Trade of Sarawak.
Institution of Electrical Engineers (Wireless Section), at 6.—Dr. N. W. McLachlan: The Application of a Revolving Magnetic Drum to Electric Relays, Siphon Recorders, and Radio Transmitting Keys.
Institution of Automobile Engineers, at 7.30.—C. W. J. Taffs: Railless Trolley Traction.

THURSDAY, April 12.

Royal Institution of Great Britain, at 3.—Prof. A. O. Rankine: The Transmission of Speech by Light (1).
Institution of Electrical Engineers, at 6.—A. G. Warren: The X-ray Examination of Materials.
Optical Society (at Imperial College of Science and Technology), at 7.30.—F. Twyman: The Hilger Microscope Interferometer.—A. Whitwell: The Form of the Wave Surface of Refraction.—J. H. Barton: A New Research Microscope of Original Design.
Institute of Metals (London Local Section) (Annual General Meeting) (at Institute of Marine Engineers, Inc.), at 8.—Dr. S. W. Smith: The Surface Tension of Metals.
Camera Club, at 8.15.—E. A. Robins: The Edible Crab.

FRIDAY, April 13.

Royal Astronomical Society, at 5.
Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Madder-stained Specimens illustrating the Process of Bone-growth.
Malacological Society of London (at Linnean Society), at 6.
Junior Institution of Engineers, at 7.30.—C. B. Clapham: Instrument Equipment of Aeroplanes.
Royal Photographic Society of Great Britain, at 8.—J. R. H. Weaver: Cathedrals of Northern Spain.
Royal Institution of Great Britain, at 9.—Prof. W. H. Eccles: Studies from a Wireless Laboratory.

PUBLIC LECTURE.

TUESDAY, April 10.

Gresham College (Basinghall Street), at 6.—W. H. Wagstaff: Geometry. (Succeeding lectures on April 11, 12, and 13.)

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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ROYAL INSTITUTION OF GREAT BRITAIN,

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GENERAL COURSES OF LECTURES AFTER EASTER, 1923.

At Three o'clock.

Sir Arthur Keith, F.R.S., "The Machinery of Human Evolution." Tuesdays, April 10, 17, 24, May 1.

Professor A. C. Seward, F.R.S., "The Ice and Flowers of Greenland," and "Arctic Vegetation of Past Ages." Tuesdays, May 8, 15.

Professor W. M. Flinders Petrie, F.R.S., "Discoveries in Egypt." Tuesdays, May 22, 29, June 5.

Professor A. O. Rankine, "The Transmission of Speech by Light." Thursdays, April 12, 19.

Professor J. T. MacGregor-Morris, "Modern Electric Lamps." Thursdays, April 26, May 3, 10.

Professor E. G. Coker, F.R.S., "Engineering Problems solved by Photoelastic Methods." Thursdays, May 17, 24.

Sir William M. Bayliss, F.R.S., "The Nature of Enzyme Action." Thursdays, May 31, June 7.

Sir Owen Seaman, "Sonnets and Ballads of Dante Rossetti." Saturdays, April 14, 21.

Dr. Leonard L. M. Williams, "The Physical and Physiological Foundations of Character." Saturdays, April 28, May 5.

Mr. John B. McEwen, "Dance Music," "Harmonic Evolution," "Musical Education." Saturdays, May 12, 19, 26.

Dr. Arthur W. Hill, F.R.S., "The Vegetation of the Andes," "The New Zealand Flora." Saturdays, June 2, 9.

Subscription (non-Members) to all Courses of Lectures (excepting the Friday Evening Discourses and the Juvenile Lectures), Four Guineas. Subscription to a Single Course, Two Guineas or One Guinea.

The Friday meetings will begin on April 13 at 9 P.M., when Dr. W. H. Eccles will give a Discourse on "Studies from a Wireless Laboratory." Succeeding Discourses will probably be given by Mr. W. J. S. Lockyer, Mr. C. V. Boys, Professor F. Soddy, Professor W. A. Bone, Mr. W. M. Mordey, Sir Aston Webb, Professor H. A. Lorentz, and Miss Joan Evans.

Information as to Membership and other matters connected with the Institution can be had at the Secretarial Office, 21 Albemarle Street, W.1.

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The Petrological Microscope will receive special attention in these Lectures.

For admission tickets application should be made to the Registrar at the above address, or the fee may be paid at the first lecture. Fee, 10s.

UNIVERSITY OF ABERDEEN.

BLACKWELL PRIZE ESSAY.

THE BLACKWELL PRIZE of THIRTY POUNDS, open to Unrestricted Competition, will be awarded in 1924 for the Best Essay, provided the Trustees are of opinion it is of a sufficiently high standard, on "The History of the Fishing Industry of the Port of Aberdeen since 1800."

Essays must be lodged with the Secretary of the University on or before January 1, 1924.

Each Essay must bear a motto, and be accompanied by a sealed envelope bearing the same motto, and enclosing the name and address of the writer.

H. J. BUTCHART, Secretary.

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UNIVERSITY OF LONDON.

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Applications for grants from the DIXON FUND for assisting scientific investigations, accompanied by the names and addresses of two references, must be made to the Academic Registrar, University of London, South Kensington, S.W.7 (from whom further particulars may be obtained) before May 15, 1923.

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UNIVERSITY OF LEEDS.

DEPARTMENT OF MATHEMATICS.

The Council will shortly proceed to the appointment of an ASSISTANT LECTURER in the DEPARTMENT OF MATHEMATICS. Duties to begin October 1. Salary £350 to £400 a year, in accordance with qualifications and experience. It is desirable, but not essential, that the selected candidate shall possess a competent knowledge of the higher portions of some branch of Applied Mathematics. Applications, stating academic career and subjects of special study, together with testimonials (one copy) and references, should reach the Registrar, The University, Leeds, on or before April 27, 1923.

NATURE

SATURDAY, APRIL 14, 1923.

CONTENTS.

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Research in Animal Nutrition.

THE recent munificent gift of 100,000*l.* made by Sir Alfred Yarrow to the Royal Society is a tribute to the service of science to industry from a great manufacturer. It is somewhat astonishing, however, how little money has been gifted for research work into agricultural problems, in view of the fact that animal husbandry, with the occupations that depend directly upon it, is the most important industry in this country, and that, in spite of the large home production of animal foods, it is still necessary to import to a value of more than 200,000,000*l.* per annum without even then meeting fully the demands for some of those animal products.

We are probably correct in stating that in no other industry has so little been done in Great Britain to develop the scientific side, to find out the most economical methods of feeding, to reduce the relatively enormous mortality among many kinds of stock, to investigate the true nutritive value of the raw materials of feeding stuffs and the processes by which they are converted into the commercial finished product. It is true that Rothamsted is a monument to a brilliant pioneer in agricultural research, but for long this institute stood practically alone. It was not until the establishment of the Development Commission in 1911, which was appointed with the object of developing rural industries, that any real effort was made to improve this disastrous state of things. The Commissioners came to the very rational conclusion that one of the most essential things was a national scheme of research in agriculture.

As the result of full inquiry the Commissioners determined to establish two centres for the study of animal nutrition, one at the School of Agriculture at Cambridge under Prof. T. B. Wood, and the other at Aberdeen in connexion with the North of Scotland College of Agriculture and the University of Aberdeen. At Cambridge advantage was taken of an already existing and excellent research organisation, which was assisted financially and developed. At Aberdeen, however, a new institution had to be established. The amount of the capital outlay was estimated at 40,000*l.* to 50,000*l.*, and of this sum 20,000*l.* was obtained from the Development Commission.

In spite of this splendid grant, if it had not been for the very public-spirited action of Dr. John Quiller Rowett, who promised an initial subscription of 10,000*l.* and a further contribution if necessary, it is probable that the establishment of the institute might have been delayed for years for lack of funds. It is fitting that the name of this generous donor, who was willing to support this experimental institute before its capacity to undertake research was proved, should be for all time associated with it. All who are interested not only directly in agriculture, but also indirectly in food production generally, are under a deep debt of gratitude to Dr. Rowett. It is pleasant to record that the example of Dr. Rowett has already stimulated an Aberdeen donor, Mr. Walter A. Reid, to give 5000*l.* towards the development of the library and the statistical department of the Rowett Institute.

The food troubles of the War ought to have brought it home to all that British agriculture was in a parlous state. Great Britain may be able to raise the finest horses and cattle in the world, but nevertheless our agriculture in general is in a backward condition. Sir Thomas Middleton before the war drew a most interesting series of comparisons showing the effect of the application of science between agriculture in Great Britain and in Germany, where the soil is inferior to ours. From each 100 acres of land the German farmer obtained 33 tons of corn to the British 15, 55 tons of potatoes to the British 11, 28 tons of milk to the British 17½, and even 4½ tons of meat to the British 4.

Research in Great Britain in other branches of science would have been in a poor state if it had had to rely in the past on support from public funds. We owe much of our outstanding position in various sciences to gifts from far-sighted private benefactors. Surely agriculture, which becomes the hobby of so many of our successful business men, ought to attract the necessary funds to assist in the investigation of problems of really national importance. There is abundant opening both at the Rowett Institute and at Cambridge for generous donors to assist, for example, by the institution of experimental farms on a large scale at these institutes. Such practical workshops as experimental farms are essential to demonstrate to the so-called "practical" agriculturist that there are ways better than his own of doing things, that will convince him, for example, that there is such a thing as the hygiene of the cowhouse and byre. Men talking and lecturing about the possibilities of doing things properly will not suffice; there must be actual demonstration of the value of the suggested change. The soil breeds an individual slow to convince, but facts tell. As Dr. Orr, the director of the Rowett Institute, has shown, even in the short time the work has been running at Aberdeen, such farms can be made to pay their way. The pig farm he established last year already shows a positive financial balance.

It must not be forgotten, too, that indirectly from these experiments on farm animals there will eventually emerge a great body of knowledge of direct use in the solution of human nutritional problems. Dr. Rowett, when conveying his donation to the Aberdeen Institute, definitely recognised this fact, and even stipulated that so far as possible the nutrition of man as well as that of animals should be kept in view.

As there is no institute or laboratory devoted to the investigation of the nutrition of man in Great Britain, these animal stations will have to be depended upon for a great deal of the information we now lack on mineral metabolism, to take a single outstanding example of a neglected field of study. We trust, therefore, that generous provision will be made for the maintenance and extension of the valuable research work on problems of nutrition being carried on at Aberdeen and Cambridge.

The King's English.

Notes on the Composition of Scientific Papers. By the Rt. Hon. Sir T. Clifford Allbutt. Third edition. Pp. xii+192. (London: Macmillan and Co., Ltd., 1923.) 6*s.* net.

SIR CLIFFORD ALLBUTT, the author of this little book, informs us in the preface that he has occasion in his capacity as a member of the Medical Faculty of the University of Cambridge to read, in the course of each academic year, some seventy or eighty theses which are presented for the degree of M.B. and about thirty which are offered for that of M.D. Of the value of such theses, as indicative of the prospective graduates' attainments or ability, there is a difference of opinion. Considering the usual age and opportunities of the candidates, and their limited professional experience, the theses are necessarily, for the most part, mere compilations culled from text-books, or from the records of cases in the medical journals. But, however limited their value, we are disposed to agree with Sir Clifford Allbutt that they serve a useful purpose. The search through the literature is of itself a salutary and desirable regimen. It serves to concentrate the student's attention on a single subject, and ends by making him a better informed man on that particular subject than he otherwise would be. Of course, much depends upon the choice of the subject. Sir Clifford's experience is that, on the whole, the candidates choose wisely. He tells us that the matter of these theses is good, often excellent. What he complains of is the manner of their presentation. In composition some are fair, and a few are good, but the greater number are written badly, some very ill indeed. "The prevailing defect of their composition is not mere inelegance: were it so, it were unworthy of educated men; it is such as to perplex, and even to travesty or to hide the author's meaning."

The purpose of Sir Clifford Allbutt's book is to direct attention to these faults of "style" and of literary composition, in the hope that candidates for medical degrees may avoid the many solecisms which their theses too frequently display. It is easy to see how they arise. The art of literary composition is seldom a part of the school training of a youth. If it is taught at all it is too frequently dealt with by a master who has no real aptitude for literary craftsmanship, whose knowledge of our literature is limited, and whose critical faculty is not very acute. To bring out the best that is in a boy, to "enthuse" him with the subject, requires a teacher of rare gifts, of wide reading, knowledge, and experience. It is far easier to teach mathematics, or the elements of physical science, or even such subjects as history or a modern language, than it is to inculcate the best method of handling such a rich and flexible language as English in written composition. The consequence is that literary composition occupies, as a rule, a very subordinate position in the curriculum of a school, and the youth enters upon his higher education or even upon his life's work with a very limited experience of the richness and beauty of his mother-tongue and with little or no knowledge how properly to deal with it.

Sir Clifford Allbutt's strictures are based mainly upon his experience of the graduation theses of medical students, but they are no less applicable to the composition of scientific papers in general. The man of science, as a rule, springs from the same class as that which furnishes the medical man, and their upbringing and scholastic training are identical. It is therefore to be expected that they should both suffer from the same disabilities. Hence the author is fully justified in the selection of the more comprehensive title which he has attached to his work. A very limited experience of the periodical literature of science affords ample proof of the relevancy of his criticisms. Scientific memoirs are too frequently mere transcripts of laboratory journals, with no proper attempt at selection, logical arrangement, economy of expression, lucidity, unity, or simplicity—the cardinal virtues which Sir Clifford Allbutt rightly insists should characterise all literature.

The book is evidently the result of much careful study of contemporary scientific literature, and it is replete with illustrations and examples of faults in literary composition to be found in scientific communications. The author's criticism is in the main constructive. If he points out a solecism, as a rule he shows how it should be avoided. At times, although he would doubtless deprecate the implication, he appears to be a little hypercritical and over-fastidious, and some exception might justly be taken to his ruling. The fact is the English language is not standardised, and it is contrary to its genius and to its progressive nature that it should be. Its character is largely determined by use and wont, and by the example and influence of the acknowledged masters of literary craftsmanship. There is no established standard of style. "The style is the man." The styles of Johnson and Addison, of Ruskin and Carlyle are as wide apart as the poles: they are individualistic and characteristic of the men. It is this variety which serves to make our language the noble instrument that it is.

He who constitutes himself a literary censor, and takes up an *ex cathedra* attitude in the matter of literary composition, especially in the case of a language such as English, needs to be very sure of his ground and to walk warily. Years ago a certain Dean of Canterbury was constrained to publish a little book on the "Queen's English." That book was somewhat pitilessly handled by Mr. Washington Moon in a rejoinder entitled the "Dean's English." This episode should be a warning to those who would rush in where angels may well fear to tread. Sir Clifford Allbutt has certainly the courage of his opinions and is not slow to tell us of his likes and dislikes, but even he, like the great Homer himself, sometimes nods, and lays himself open to rebutting criticism. At the same time, his book is well worthy of the attention and careful study of all who seek to write correctly, and with a pious regard to the splendid inheritance they possess in their mother-tongue.

Eastern Tibet.

Travels of a Consular Officer in Eastern Tibet: together with a History of the Relations between China, Tibet, and India. By Eric Teichmann. Pp. xxiv + 248 + 64 plates + 8 maps. (Cambridge: At the University Press, 1922.) 25*s.* net.

EASTERN Tibet remains the least known part of Asia in spite of its exceptionally interesting problems. An important contribution to its geography has now been made as one of the indirect results of the British expedition to Lhasa in 1904. The Chinese then feared the annexation of Tibet to India, and to avert this danger immediately sent an agent to Eastern Tibet; in the following year, this "Amban" and his escort were massacred, and several French missionaries were murdered at their stations along the Tibetan frontier. To suppress the revolt Chao-erh-feng invaded the country, and Chinese authority was established and agents reinstalled in Lhasa.

Chao-erh-feng was a man of remarkable capacity, and he secured the personal trust of the Tibetans by a policy which protected them from the tyranny of the lamas, and by the severity with which he punished any ill-conduct by his own soldiers. During his rule the Chinese position in Tibet was secure. When the Manchu Dynasty was tottering he was recalled eastward and made Viceroy of Szechuan. He was executed in Cheng-fu, the capital of that province, by the revolutionists in 1911, after a heroic effort to maintain the old government. The author fully recognises the genius of Chao-erh-feng, whom he describes as "one of China's greatest Empire builders," and says that "with him passed away Chinese ascendancy over Tibet." He adds that Chao-erh-feng's justice and fair dealing are still remembered. This tribute to the great Chinese administrator is the more weighty as the author's sympathies are rather pro-Tibetan.

After Chao-erh-feng's death Chinese rule in Tibet promptly collapsed. The Tibetans in 1912–13 recovered most of the lost country, and after a five years' truce resumed their eastward advance in 1918. There was then no Chinese force available for the defence of Western China, but there can be little doubt that if the Tibetans had seized some of the territory they coveted, the Chinese would reconquer it as soon as the internal difficulties in China are smoothed down. To avoid a prolonged war between Tibet and China, the British Government used its influence to secure a peaceful settlement. Mr. Eric Teichmann, then the British Consul at Ta-tsien-lu, acted as the local mediator, and in this volume he tells the story of the Tibeto-Chinese war and negotiations, and describes the journeys he made during his efforts to arrange peace. By great tact and patience he persuaded both sides to accept a temporary arrangement which may be ultimately adopted without loss of prestige to either side. He induced them to revert to the frontier which had been recognised from 1727–1905. During these negotiations Mr. Teichmann had exceptional opportunities for travel in unknown parts of Eastern Tibet. He is an enthusiastic and capable geographer, and made the best of his chances. The volume in which he records his experiences and observations will remain one of the standard works on the geography of East Central Asia.

The district including most of his routes lies north of the Ta-shueh-shan or Great Snow Mountains, which rise on the northern side of the famous road from China to Lhasa. From the foot of these mountains extends a vast tract of down country about 13,000 ft. above sea level; it is dissected by valleys from 2000 to 3000 ft. deep, and rises into high snow-covered ranges of which the heights and relations are unknown. Mr. Coales, the author's predecessor at Ta-tsien-lu, has shown that the country is largely composed of red sandstone and limestone. This view is confirmed by Mr. Teichmann; but there is no evidence as to which of four possible series this limestone belongs, and without further information as to the geological structure and trend of the snow-capped mountains, the fundamental structure of the country remains uncertain. Mr. Teichmann's careful observations are the more useful owing to the excellent index. There are numerous photographs, a series of seven sketch maps, and a large map of Eastern Tibet reprinted from the *Geographical Journal*.

J. W. G.

Hereditary Diseases of the Eye.

University of London: Francis Galton Laboratory for National Eugenics. Eugenics Laboratory Memoirs, 21. *The Treasury of Human Inheritance.* Vol. II.: Anomalies and Diseases of the Eye. Nettleship Memorial Volume. Part I.: Retinitis pigmentosa and allied diseases; Congenital stationary night-blindness; Glioma retinæ. By Julia Bell. With a Memoir of Edward Nettleship by Dr. J. B. Lawford. Pp. xv+123+26 plates. (Cambridge: At the University Press, 1922.) 45*s*. net.

All students of genetics will welcome the resumption of publication of "The Treasury of Human Inheritance," interrupted, like so many other scientific researches, by the War. Prof. Karl Pearson has now been able to issue Part I. of the Nettleship Memorial Volume, devoted to retinitis pigmentosa and allied diseases, congenital stationary night-blindness, and glioma retinæ. The report on and pedigrees of these diseases is preceded by a memoir of Edward Nettleship, written by his old colleague, Dr. J. B. Lawford. Nettleship was a fine example of the combination of clinician and researcher, which, to the honour of British medicine, has been frequent in this country and perhaps especially frequent in the department of ophthalmology. Dr. Lawford has well brought out Edward Nettleship's sterling qualities, which added lustre to a family distinguished in the fields of pure scholarship and philosophy. Nettleship possessed, to a very eminent degree, the patience, powers of observation, and natural sagacity which are essential to success in the investigation of problems of inheritance. His career adds one more to the numerous proofs that arduous medical practice is no barrier to distinguished success in pure science.

The composition of the work was entrusted to Dr. Julia Bell, who has acquitted herself admirably. The discussion of the genealogical material is preceded in each case by an historical and anatomical account of the anomaly in question which, while scientifically adequate and strictly impartial, is intelligible to the educated layman. The pedigree plates maintain the very high standard of achievement set by former publications of the Galton Laboratory. With the exception of glioma retinæ—a rare and malignant disease—few of the conditions here dealt with threaten life, while nearly all of them so greatly interfere with the comfort of existence—in some cases making it impossible for the victim to follow his profession—that their recognition is frequent. It would therefore be expected that a large amount of genealogical material should be available. Such is the case, but the absolute frequency of the diseases is small, and in many instances, such as that of the classical Nougaret family, victims are by no means anxious to reveal their disability to strangers.

It is particularly appropriate that the volume should be dedicated to the memory of Nettleship, for a large share of the material relating to retinitis pigmentosa and the lion's share of the data of congenital stationary night-blindness are the product of his own researches.

"The Treasury" is planned to be a storehouse of facts, so that no complete analysis of the data is attempted; but certain interesting points are made. Attention is specially directed to two: (1) the presence of other defects in the family histories, (2) the etiological importance of consanguinity. As to (1), it would seem that each of these defects tends to occur largely as a single defect, but that if retinitis pigmentosa is associated with deafness in the stock the link is a close one. With respect to (2), consanguineous marriages are far more common in the diseased stocks than in the general population, save in the case of that form of congenital stationary night-blindness which is limited to males. In only one case, however, does the proportion of affected offspring of consanguineous marriages seem to exceed materially that found among the offspring of non-consanguineous marriages, a result differing from what has been observed in the records of deaf-mutism and albinism.

The very rare and usually fatal anomaly, glioma retinæ, scarcely lends itself to statistical treatment. However, in view of its absolute rarity—it is estimated not to furnish more than 0·03 per cent. of all patients suffering from diseases of the eye—the fact that it has been possible to compile thirty-six histories showing more than one case in a stock is strong evidence that this, too, is an hereditary defect.

In a prefatory note, Prof. Karl Pearson thanks the Medical Research Council for a grant in aid of the work, and expresses a "hope that the work as completed will be considered to have justified their support." The scientific public will have no doubt on that score; there could be few objects more worthy of national support than the preparation of scholarly and impartial records of the facts of human inheritance. Dr. Bell has, in our opinion, produced a thoroughly satisfactory monograph, which will at once take rank as a standard work while being—a quality by no means to be predicated of all standard works—adequate from both the literary and the artistic points of view.

Chemical and Physical Tables.

Tables annuelles de constantes et données numériques de chimie, de physique et de technologie. Vol. IV.: Années 1913–1914–1915–1916. Première partie. Pp. xxxii + 626. Deuxième partie. Pp. xxxv + 627–1377. (Paris: Gauthier-Villars et Cie.; London: Cambridge University Press; Chicago: University of Chicago Press, 1921–1922.) 2 parts, 7*l.*

FOR reasons which are not very clear, the earlier volumes of the "Tables annuelles" have not been fully used in this country; but a cursory inspection of Volume IV. will give the physico-chemical doubter cause to think, while an hour's serious use of it will convert him completely. Which of us can lay his hand on his heart and say that he has missed nothing essential to his subjects of research? Let him open these volumes and—unless he has already consulted them — he will be humbled. Landolt-Börnstein carries us up to the end of 1911; from that time onwards, no indexes or abstracts, however complete of their kind, afford a sufficient guide to the seeker after data, who must nowadays add to his scientific equipment the faculties of a British Museum historian and the time in which to exercise them.

There are here recorded the classified, clearly indexed data amassed during four years from 340 periodicals and other sources by 32 abstractors in 19 countries, collated by 27 well-known compilers who are specialists, and edited by Dr. Charles Marie (to whose devotion and enthusiasm the "Tables annuelles" so largely owes its existence and its success). The general control is vested in an executive of eight eminent physical chemists from a powerful international committee representing 23 nations.

It is obvious that to neglect the output of such an organisation as this would be sheer waste. In the writer's opinion (formed in spite of a hitherto somewhat inert attitude towards the earlier volumes) there is no library of physics and chemistry, pure or applied, which can now afford to be without this publication. The price seems high at first sight; but it is an investment which will repay itself many times, even before the next volume appears.

In the plan of the work much has, naturally, been gained from Landolt-Börnstein, but the scope is considerably wider and at the same time more detailed.

A series of practical tests in various sections shows that it is easy to trace at once the information sought; and to this end a system has been adopted in which rigidity has been tempered very wisely. There are chapters in Part II. which one might have expected to be placed near others in Part I.; for example, thermochemistry is separated from thermodynamics in this way, and cryoscopy from vapour pressures; but some change in the sequence of sections may doubtless be made hereafter, and in the meanwhile there is no obstacle to utility. The printing is clear; and with the tabulated data the compilers give sufficient indication of the experimental method used, mention any general formulæ found applicable by the author, and state the conditions quite unambiguously. The use of graphs instead of tables in dealing with subjects such, for example, as absorption-spectra, equilibrium mixtures of metals, or the ignition of gaseous mixtures, is well carried out. In chapters treating of organic compounds Richter's classification is used; and it is clear that the vexed question as to the organic or inorganic nature of calcium carbide would present no difficulty to the editor, for he provides the useful category of "Corps mixtes." This name, however, although no doubt correct in French, should certainly not be rendered in English as "mixtures." The misspellings of English authors' names are probably not more frequent than can be matched in English references to foreign literature.

Dr. Marie prints his regrets that this volume, covering 1913–1916, is only now issued; but, as in the case of Dr. Johnson's dog, the marvel is, not that it is done so well, but that it is done at all; for the difficulties during and just after the War must have been very great. That these difficulties have been passed, so that we have Volume IV., are informed of an accelerated issue of Volume V. (1917–1921), and may look for a regular progression thereafter, is a real achievement in advancing research. I. M.

Our Bookshelf.

Modern Tunneling. By David W. Brunton and John A. Davis. (New Chapters on Railroad Tunneling, by J. Vipond Davies.) Second edition, revised and enlarged. Pp. x+612. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 33*s*. net.

The first edition of this work was published in 1914, and its contents were limited to mine and water-supply tunnels. The present edition has been revised and enlarged by Mr. John Vipond Davies, and contains new matter dealing with large-sized tunnels. The early part of the volume contains a very good discussion on the plant required in the construction of tunnels, and includes such subjects as the factors influencing the choice of prime movers, types of air compressors, surface plant generally, and methods of ventilation. This is followed by critical descriptions of the various underground appliances, such as rock-drilling machines, the methods of blasting, haulage, etc. The great development of tunnels during the last fifty years has been due to the application of high explosives and rock-drills, and this part of the subject receives adequate treatment. Details of the cost of a large number of tunnels are included, together with the speeds attained in driving them. There are two comprehensive bibliographies, and these may be regarded as an essential feature in a book on this subject and of moderate dimensions. The matter is presented in a very readable manner, and the volume will be of service not only to the engineer engaged in practice but also to the student of civil engineering.

La Force motrice électrique dans l'Industrie. Par Eugène Marec. Pp. viii+613. (Paris: Gauthier-Villars et Cie., 1922.) 55 francs.

M. Marec's book is written for those who, having a sound theoretical knowledge, are more concerned with the choosing and installing of electrical machines than with the manufacture of them. The operation of the finished machine is discussed mainly by describing its characteristic curves. The engineer is thus enabled to judge which type of machine will prove the most useful for the particular purpose he has in view. The various methods of installing electrical machinery in a workshop are fully described. The book will be of use to the English engineer, as it will show him the best modern French practice, and it will be helpful for him to compare it with his own. The various French methods of charging for alternating-current power will interest him. One method is to charge the consumer for the watt-hours he has consumed. In addition a further charge is made for the magnetising hours, this further charge only being zero when the consumer uses apparatus the power factor of which is unity. The latest French rules for standardising apparatus and methods in electrical engineering are given. The comparison of them with the American and English rules is instructive.

Orographical, Regional, Economic Atlas. Edited by T. Franklin. Part 4: Africa. Pp. 32. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd., n.d.) 1*s*. 6*d*. net.

This collection of forty-seven diagrams and maps of Africa and parts of Africa is wonderfully good value. It includes a coloured orographical map of the whole of Africa and sectional maps of the same on enlarged scales. A uniform scale for these sectional maps would have been an advantage. The maps appear to be accurate and revised to date. The allocation of the Cameroons to the League of Nations on one map is apparently a slip. The atlas deserves a wide use.

The All-Electric Age. By A. G. Whyte. Pp. xiii+242. (London: Constable and Co., Ltd., 1922.) 7*s*. 6*d*.

Mr. Whyte gives an interesting and accurate account of the latest electrical developments. He has refrained from speculating about the future, but we think that if he had pointed out the directions in which advances will probably be made he would have added to the interest of the book.

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.*]

The Cause of Anticyclones.

In reply to Major Goldie's letter in Nature of March 31, p. 429, the following figures may be of interest.

Defining an anticyclone as a region where the barometric pressure exceeds 30·20 inches (1022·7 mb.), there are 52 cases of anticyclones in the British Isles during the years 1909 to 1922 inclusive in which the results of registering balloon observations are available.

Expressed as a departure from the mean for the height and date, these 52 cases give $+1·6°$ F. at 1 km., $+4·5°$ F. at 2 km., and $+5·6°$ F. at 3 km. for the mean departure in an anticyclone. At 1 km. there are 18 negative values, at 2 km. there are 16, and at 3 km. there are 13. Ten instances, or only about one in five, show negative departures at each height.

For cyclones with a barometer reading below 29·40 inches (995·6 mb.) the corresponding mean figures are $-6·1°$ F., $-8·3°$ F., and $-9·7°$ F., with 3, 2, and 1 positive signs respectively, out of 27 cases.

The above figures, the results of observations published by the Meteorological Office, do not seem to me to point to the conclusion that in England anticyclones are formed by pockets of cold polar air, but another test is available.

As I understand the theory of the Polar Front, polar air should be cold and have a low relative humidity; cold because it comes from a colder latitude, and dry because it is gradually warming up without a fresh supply of water and hence has a decreasing humidity. Conversely, equatorial air should be warm and nearly saturated. Where, then, polar air lies under equatorial air and forms a discontinuity, the inversion of temperature should be associated with an increase of relative humidity in the upper layer. Actually, just the reverse is the case.

I have examined the published figures for the continent, where records of the humidity are available for the years 1910 and 1911 separately; both years are consistent, and the combined result of nearly 300 observations is as follows:—

Percentage value to the nearest digit of observations in which an increase of relative humidity accompanies a temperature inversion, 0 per cent. Cases of inversion with no appreciable change of humidity, 4 per cent. Cases with distinct decrease, 36 per cent. Cases with very distinct decrease, 22 per cent. In these results both surface inversions and those over 3 km. are excluded.

Since the figures are not published on a homogeneous plan, classification is difficult, but "No appreciable change" means 5 per cent. or under, and 'Distinct decrease" means a fall of 20 per cent. or more.

One solitary instance of an increase of humidity exceeding 5 per cent. (it was 6 per cent.) was found; it occurred at Vienna on December 6, 1911.

The continental figures are fully supported by many hundreds of kite ascents in England, and they prove that cases of warm damp air overlying colder and drier air are practically non-existent.

Thus it appears from the abundant observational material available that the lower layers of the atmosphere are almost always cold in a cyclone, and are usually (three cases out of four) warm in an anticyclone; also that when an inversion of temperature occurs it is nearly always associated (58 cases out of 62) with dry rather than damp air above.

W. H. Dines.

Benson, Wallingford.

Hypotheses of Continental Drift.

In many recent discussions of Wegener's theory and of other geological hypotheses, the assumption has been freely made that any force, however small, can deform the earth to any assignable extent if only it acts long enough. To declare that this assumption is incorrect is scarcely possible, in the absence of much more accurate knowledge of the physical conditions within the earth than we at present possess; but there is substantial evidence against it.

We believe that mountains have stood for millions of years, indicating that the rocks at their feet can endure for that time stress-differences equal to the pressure at sea-level in the middle of a mountain. The strength of rocks at depths of 200 to 400 km. is almost certainly less, but no geodetic observations indicate that the strength is insufficient to support an uncompensated hill 200 metres in height; inequalities greater than this appear on the whole to be compensated, but the unexplained gravity anomalies remain almost the same whether we suppose that inequalities less than 200 metres in height are compensated or not. Other data, however, indicate that isostasy is not always perfect: Dr. Morley Davies has pointed out one, and I have shown that several otherwise uncoordinated data can be coordinated on the hypothesis that the rocks in the asthenosphere, though weaker than those near the surface, have a finite permanent strength. Accordingly, the hypothesis that the asthenosphere can be deformed to an unlimited extent by any small force acting for a long time is one to be regarded with great suspicion, and not to be accepted until it has been proved that it will account for more than appears to be explicable on the contrary hypothesis.

In conjunction with this hypothesis another is often utilised, which can be definitely stated to be inconsistent with physical knowledge: namely, that such a small force can overcome a much larger force acting for the same time in the opposite direction. In Wegener's theory, for example, not only is a small force supposed to have moved America across the Atlantic, but also the resistance of the ocean bottom to deformation is supposed to have caused the elevation of the Rocky Mountains. Now, given a sufficiently weak asthenosphere and enough time, it would be possible to twist the outside of the earth over the inside to any extent. So long as the layers of equal density remained symmetrical about the polar axis, no elevation or depression of rocks taking place, deformation could proceed undisturbed, America going steadily on its way without mountain-building or any other phenomenon observable by geologists. In order that mountain-building may take place, however, energy must be supplied to raise and lower the rocks affected against gravity; and to keep them in position, in spite of the tendency of gravity to restore the symmetrical form, the force required must be enough to overcome gravity and the strength of the surface rocks. The minimum stress needed to account for mountain-building is therefore greater than the pressure due to the weight of the mountain. Tidal friction and differences between the values of gravity at the tops and bottoms of continents are capable of producing stresses of the order of 10^{-5} dynes per sq. cm., whereas to elevate the Rockies something like 10^9 dynes per sq. cm. would be required.

A hypothesis that may be of use in accounting for continental drift, if the latter is considered to be indicated by the geological evidence, is based on Jeans's proof (Proc. Roy. Soc. 93, 1917, 413-417) that the earth is stable with regard to first harmonic deformations. The fact that most of the land is in one hemisphere indicates that a first harmonic deformation exists, and must therefore be tending to die down; the only possible means of destroying the asymmetry being for the continents to break up and spread out so as to get as far apart as possible. If, then, we are prepared to admit that the continents were once all united into one mass, it is probable that they would have broken up and separated widely, since the stresses in them must have been comparable with the pressure at sea-level due to the weight of a continent, which is at any rate a moderate fraction of the strength of rocks. Wegener's suggestion that India has moved towards the main mass is, of course, inconsistent with this hypothesis.

The possibility that the continents were formerly united has been regarded by Mr. Crook (Nature, February 24, p. 255) as in harmony with Osmond Fisher's theory of the origin of the Pacific. The latter theory, however, is open to a serious objection. The birth of the moon on the resonance theory would require a violent distortion of the earth, sufficient to shatter into fragments any crust that might have already been formed, and these would distribute themselves symmetrically over the liquid interior at once instead of waiting a thousand million years to do it.

Prof. Sollas's suggestion, mentioned by Dr. Evans in Nature of March 24, p. 393, that there are traces in the earth of the incipient formation of a second satellite, is not in quantitative accordance with the resonance theory of the origin of the moon. It is practically certain that the earth-moon system, when combined into one body, did not rotate sufficiently fast for instability, but it is just possible that it could have rotated fast enough for resonance to magnify the solar semidiurnal tide to such an extent as to rupture the mass into two parts. If the moon was formed in this way, however, it must have taken away with it so much angular momentum that the earth could never again have approached conditions suitable for either resonance or instability.

Harold Jeffreys.
St. John's College, Cambridge.

The Life-Cycle of the Eel in Relation to Wegener's Hypothesis.

The argument in Dr. Wemyss Fulton's very interesting letter in Nature of March 17, p. 359, must be divided into two parts. First, it is pointed out that the gradual recession of the east and west coast-lines of the North Atlantic Ocean from one another would explain in a very satisfactory manner the evolution of the amazing migrations of the larval eel. Secondly, it is assumed that Wegener's continental drift is the only method of effecting that gradual recession. It is possible to concur heartily with the first thesis, without admitting the second.

Suess explained the North Atlantic Ocean as having been formed, during the later ages of the Cainozoic era, by successive foundering of portions of a pre-existing land surface. Except that the recession of the two coasts would then have been spasmodic instead of continuous, the general result from the point of view of the inhabitants of the sea would be just the same as if the two continents were drifting apart. While acknowledging our indebtedness to Dr. Fulton for pointing out how the life-history of the eel fits in with the other evidences of a gradually widening Atlantic, we need not admit that these wonderful migrations prove continental drift any more than the migration of birds across the Mediterranean proves that Africa has drifted away from Europe.

A. Morley Davies.
Imperial College of Science and Technology,
South Kensington, S.W.7,
March 19.

The Combination between Oxygen and Hæmoglobin, and the Criteria of Adsorption.

Hæmoglobin combines with oxygen approximately in the ratio of 16,670 to 32, by weight, as was shown by Peters (*Journ. of Physiol.*, vol. 44, p. 131). It is clear, then, that in solution the particle of hæmoglobin is very much larger than the particle of oxygen which combines with it. If one might assume that the densities and shapes of the particles were similar, then their surfaces would be in the ratio 64 to 1; in any case, and whatever the degree of aggregation of the particles, probably only a very small part of the surface of the hæmoglobin particles can be actually covered by oxygen when combination ceases at the stage of oxy-hæmoglobin.

This shows that the attraction of hæmoglobin for oxygen is a highly localised property of the hæmoglobin particles. For if this attraction were more or less evenly distributed over the surface, it would be satisfied only to a small extent, when a small part of the surface was covered, and at higher concentrations of oxygen than those which are found experimentally to give saturation with oxygen, more oxygen would be taken up.

Taking the thermal motions of the particles into account does not affect this argument, since the movements of the particles according to the laws of the kinetic theory do not affect their surface areas.

Now, if the attraction of hæmoglobin for oxygen is of such a character that it is satisfied when only a small portion of the surface is covered, it seems impossible to regard this combination as a case of adsorption.

The criteria of adsorption are perhaps not yet so well defined as could be wished, if differences of opinion as to whether a given process should be classified as adsorption or not are to be avoided. I am inclined to think that a process is rightly classified as adsorption, *if the substance taken up by the surface continues to be taken up until the whole surface is uniformly covered*, but not otherwise. Covering the surface uniformly is of course meant in the sense in which a gas or homogeneous solid is said to fill space uniformly; that is, uniformly to a being armed with a microscope to which individual atoms are small.

This definition is both definite theoretically, and in accordance with common conceptions of adsorption. It is difficult, indeed, to see what other definition is possible in the present state of knowledge. It is perhaps, however, desirable to state the definition clearly; although, as I feel it must have been present, whether formulated or accepted as self-evident, to the minds of many workers on adsorption, no sort of novelty is claimed for it here.

A definition of adsorption based on the nature or quality of the forces attracting the adsorbed substance, is now impossible, since it appears proved by Langmuir's work that there is no difficulty in accounting both qualitatively and quantitatively for many cases of adsorption, by means of the already very familiar forces which cause combination between metals and oxygen to form oxides, or the forces which bring about solution.

Obviously adsorption cannot be defined as "that which occurs at the surface of a colloid"; since colloids themselves are not yet a well-defined class of substances, and indeed the best studied cases of adsorption are at plane interfaces, not at the surfaces of colloids.

With the definition of adsorption proposed, a process would be excluded if, as with hæmoglobin and oxygen, combination occurs only at some defined locality on the surface. Similarly, the ordinary reactions of organic chemistry will be excluded, as they should be, since the substances taken up go to definite atomic groupings in the molecule. The combination of oxygen with hæmoglobin is seen to belong to the same class as most organic reactions.

It remains to examine whether the definition is practically applicable to known cases of adsorption, as well as theoretically justified; and whether, in the case of oxygen and hæmoglobin, the arguments originally put forward in support of the adsorption process are cogent enough to override the definition.

All cases of adsorption, from a gaseous phase, or from solution, on plane, or nearly plane, interfaces, are obviously compatible with the definition, since the common method of calculating the amount of adsorption assumes uniformity of distribution on the surface, and the results are generally expressed per sq. cm. of interface.

In the cases of adsorption on colloidal surfaces, when the extent of surface is usually not known, and the adsorption is expressed per gram of adsorbent, the definition is probably also applicable. Mecklenburg (*Zeitsch. f. physikal. Chemie*, vol. 83, p. 622) described experiments showing in several cases that the adsorption on different specimens of the same adsorbent, prepared, however, under different conditions, varied in a precisely similar way with concentration for each adsorbent, but the total amount adsorbed per gram was proportional to a factor in each case, this factor being presumably proportional to the area of the adsorbent.

In proposing the theory that the oxygen in oxyhæmoglobin is held by adsorption, Wo. Ostwald (*Koll. Zeitsch.*, vol. 2, pp. 264, 294) based the argument on two supposed facts: first, that no definite saturation point of oxygen with hæmoglobin could be found, a fact now shown to be incorrect; and, second, that the amount of oxygen taken up at different pressures could be fairly accurately represented, under certain conditions, by the so-called "adsorption isotherm," $y = kc^n$ (y = amount taken up, c = concentration of oxygen).

The mere fact that the variation of the amount taken up fits the "adsorption isotherm" does not seem now to be a sufficient ground for classing a process as adsorption. The "isotherm" has, until quite recently, been an empirical fact without theoretical explanation; and not only does it contain two independent arbitrary constants, which makes the fitting of a set of experimental data easier than would be the case otherwise; but also it is, at the best, usually only accurate at low concentrations, divergences being found at higher concentrations.

A more accurate equation relating amount adsorbed to concentration has been deduced recently (Henry, *Phil. Mag.*, vol. 44, p. 689, 1922) on the assumptions of a small range of molecular attraction and a monomolecular adsorbed layer, using well-established equations of the kinetic theory; and the author also gives a derivation of the "adsorption isotherm" on theoretical grounds. It would seem undesirable, however, to use the form of the relation between amount adsorbed and concentration as a criterion of adsorption, for this relation can never be a very simple conception, depending as it does on so many factors; but nothing could be simpler than to conceive of a surface as possessing either localised or diffuse attraction for a substance it takes up. It may be that in some instances it is not yet possible to form any estimate of the fraction of the surface covered; yet as accurate knowledge of the dimensions of molecules and of their orientation on surfaces accumulates, the applicability of the criterion here suggested will increase. I have tried to show, however, that it is already more generally applicable than any other.

N. K. Adam.

The University, Sheffield, March 6.

Labour and Science in Industry.

The article by "F. S. M." under this heading in Nature of March 24, p. 385, emboldens me to inquire whether the time has not come for a really searching scientific re-examination of the natural fundamental basis of the economic system under which we perish. That it is necessary to ask such a question as that in this article, whether, after a century's unparalleled progress in the domination of the forces of Nature and the fertile labours of inventors and producers, the average lot of the people is really better than it was in consequence, suggests a certain lack of scientific imagination. The question which many thoughtful people are now asking themselves, and which a few scientific men at least should have asked before the War, is not whether the material lot of the people is up to what it was before the use of science, but why is it not vastly improved. What kind of a civilisation ought to be the result, if science were directed in accordance with natural laws to the constructive purposes of life, rather than only so for the purposes of mutual destruction? Civilisation can scarcely revert in peace-time to economic law, in which the tokens of wealth usurp the place of reality, without raising the very general aspiration that the advantages of war and peace might be combined by proceeding according to natural laws in peace-time.

The first economists, the French Physiocrats, did make an effort to base their system on the laws of Nature, and in their doctrine, that the origin of wealth was the land, and in the later doctrine of Marx, that it was in human labour, certain obvious elements of natural truth were embodied. But in the present system there is no natural truth obvious at all. It is an offence against common sense. The production of wealth to-day is a relatively finished science, in which probably little that is fundamental remains unknown; whereas a century ago it was an empirical art as different from the present science as astronomy is from astrology or chemistry from alchemy. But the science of distributing the product—that is, the science of token wealth—is so little understood that the most incredible consequences are accepted as natural and inevitable.

In a natural community, if people were short of the necessities of existence, and knew how, they would produce and consume them. In ours, with the return to conditions of peace and victory, they are idle by the million and deteriorate mentally, morally, and physically, dumbly acquiescent in the requirements of a system no one pretends to understand. If one asks why, it is because of certain conventions with regard to bits of metal and paper to which we have all been born and brought up, but to which probably not one in a hundred, even among scientific men, has given two minutes' original thought.

The great clarification of ideas which distinguishes modern science, and especially physical science, ought not to stop short of this most vital and fundamental problem which so menaces the well-being of the community. It is, indeed, a most fascinating problem for its own sake. The mathematician would enlarge his knowledge of the consequences of a mistake in sign in a field where such mistakes are of fearful import to whole nations, and the physicist, of a perpetual-motion machine fallacy underlying and destroying the hopes, not of a half-crazy would-be mechanic, but of a half-crazy would-be mechanical civilisation. In his well-known book, "Instincts of the Herd," Mr. Trotter has put one obvious point inimitably. "It is this survival, so to say, of the waggoner upon the foot-plate of an express engine, which has made the modern history of nations a series of such breathless adventures and hairbreadth escapes." I venture to suggest that the survival of the herd-instincts of the waggoner in an express age applies as much to those who have built the express as to those who try to drive it.

The British Association naturally suggests itself as providing the proper platform for this proposed re-examination of the physical basis of our economic system, since it has an Economics Section which, no doubt, would welcome as eagerly as the public the introduction of an element of science into its proceedings. One needs to be only a casual observer of the trend of events to know that the public, thoroughly alarmed by the consequences of peace, and fearfully awaiting asphyxiation in the next war, would take an interest in this question that would rival that of the palmy days of Huxley and the Bishops.

Frederick Soddy.

We shall all sympathise with Prof. Soddy's desire that our industrial system should give a state of society in which the material lot of the people should be "vastly improved" by the application of science. We should differ from him in various degrees as to the extent to which this has been already secured, and the means which should be taken to accelerate the process. I gave in the article quoted some reasons for believing that considerable improvement had taken place: it seems, in fact, untrue to say that "we are perishing" under our present economic system. The only country which can be said to have come near to "perishing" is Russia, which attempted entirely to discard the system and is now, after a desperate experience, painfully and slowly retracing her steps. The next most seriously distressed country in the world is China, which has never attained to our modern industrial system.

By all means enlist the Economics Section of the British Association in a discussion of the problem—or rather the host of problems—involved. But do not antagonise the Section at starting by suggesting that it would be a good thing to introduce "an element of science into its proceedings." The Section has been proceeding on that assumption for a good many years now.

F. S. M.

Tactile Vision of Insects and Arachnida.

With reference to Commander Hilton Young's suggestion noted on p. 409 of Nature for March 24, it may possibly be of interest to record the conclusion at which I and my colleagues arrived, when engaged, two years ago, in research on the so-called eyes in insects and arachnida. In all the species studied, including the house-fly and red ants among the former, the house spider (*Tegenaria domestica*) and many of the Epeiræ among the latter, we were forced to the conclusion that the organs generally known as eyes do not act as organs of vision. What their main purpose is, was never *certainly* determined by us; but the many phenomena which were studied as evidence of sight could all be reduced to *touch* sensations. For example, to take perhaps the simplest illustration, if the hand be slowly advanced towards a fly on a window-pane, the insect, if it be a vigorous specimen, will evade the caress. But if the hand be advanced towards the fly when the insect is on the opposite side of the glass to the hand, it may often be necessary to tap severely in order to disturb its wanderings.

Apart from air currents due to the motion of the hand, and possibly some convection currents due to the heat of the same, it is difficult to afford any other satisfactory explanation of this simple phenomenon, which any one can examine for himself with the greatest of ease.

J. P. O'Hea.

St. Beuno's College, St. Asaph,
March 24.

The Resonance Theory of Hearing.

The difficulty expressed by Sir James Barrett in Nature of March 24, p. 396, is probably more apparent than real. If attention is focussed on the relative dimensions of the various parts of the cochlea rather than their actual sizes, I think that the range of analysis can be explained.

In the short compass of a letter I cannot deal with a full consideration of the analytical mechanism of the cochlea. A variation in pressure applied to the *fenestra ovalis*, if it is to cause a movement of the basilar membrane, must cause movement of the liquids in the cochlea. The impedance due to the inertia of the liquid is considered by Mr. Wilkinson as a "load" on the vibrating strings. In all considerations of the action of the cochlea the influence of the viscosity of the liquid has been overlooked (see *Philosophical Magazine*, 1922, vol. 43, p. 349). The friction of the liquid against the walls of the cochlea impedes the movement of the liquid so that if the diameter of the cochlea were uniform the resistance would be proportional to the distance from the *fenestra ovalis*. As the cochlea becomes narrower this is a safe assumption. If the highest audible note acts on the basilar membrane 5 μ from the commencement of the cochlea, the ratio of the impedance due to viscosity of this highest note to the lowest note might be 35,000 to 5. This is approximately the ratio given by Mr. Wilkinson without the assumption of any difference in tension in the fibres of the basilar membrane. I do not wish to imply that there is no difference in tension, but the greater bulk of the spiral ligament may be merely to resist a greater strain, and is not necessarily an indication of a greater initial tension.

If one wishes to look at this subject from the point of view of resonance, the effect of viscosity can be illustrated by narrowing the orifice of an air resonator. This lowers the note, just as the viscosity makes the note lower for the distal end of the cochlea, but the viscosity of a liquid will be much more important than the viscosity of a gas. Viscosity, however, is only one of the factors concerned in sound analysis.

H. E. Roaf.

London Hospital Medical College,
Whitechapel Road, E.1,
March 26.

The Sun-Cult in Ancient Egypt.

By Aylward M. Blackman, D.Litt.

I.

THE recent discovery of Tut'enkhamūn's tomb has naturally aroused a great deal of interest in the attempt made by that king's father-in-law, Ōkhnatōn, to establish a monotheistic form of sun-worship as the State religion of Egypt, and indeed of the whole Egyptian empire. Properly to appreciate this very striking phase of Egyptian religious thought, it is necessary to have some knowledge of the old "orthodox" sun-cult, the State religion of Egypt, since at any rate the sixth, and possibly the third dynasty—a cult which can be traced back to the very dawn of Egyptian history.

The centre of this ancient sun-cult was On, the Heliopolis of the Greek writers, a city which lay close to Memphis and the site of modern Cairo. Heliopolis was almost certainly the political centre of a united Egypt in the predynastic period, though at a time not necessarily long anterior to the beginning of the first dynasty and the founding of Memphis by Menes. The predynastic king of Heliopolis was high-priest of his city-god, the sun-god Rēʿ-Atum, and was also regarded as his embodiment. Immense influence was exercised by Heliopolis upon Egyptian theology and ideas in general, and even when Heliopolis ceased to be the actual capital of Egypt, the Egyptian king was still regarded as the embodiment of the sun-god and his high-priest, and Rēʿ-Atum still maintained his place as the State-god. Owing to the religious and political ascendancy of Heliopolis, a number of the local provincial gods were identified with the sun-god by their priests in order to enhance their prestige. Of course, this identification was particularly likely to take place when what was once a provincial town became the centre of government, as did Heracleopolis at the beginning of the ninth, and Thebes at the beginning of the eleventh dynasty.

As a result of their being identified with the Heliopolitan sun-god, and owing to the great prestige, and, no doubt in early times, superior culture, of Heliopolis, the temples erected for the worship of the solarised local gods were copies of the Heliopolitan sun-temple; moreover the liturgy celebrated therein in honour of these divinities was that celebrated in honour of their Heliopolitan prototype. In course of time the Heliopolitan form of temple was universally adopted in Egypt, and also, by a natural process, the Heliopolitan liturgy came to be celebrated in honour of every important god and goddess throughout the length and breadth of the land. This remarkable uniformity in temple architecture and in worship seems to have prevailed so far back as the old kingdom, about 2900 to 2475 B.C.

The king of Egypt, as we have seen, was the high-priest of the sun-god. He was also high-priest of all the local divinities of Egypt, and in this capacity he celebrated, or rather was supposed to celebrate, the liturgy in every Egyptian temple. His relations with the solarised divinities were of course practically the same as his relations with the Heliopolitan sun-god himself, a circumstance which naturally must have influenced his relations with other divinities and must have helped forward greatly the solarisation of all Egyptian temple-worship.

What, it may be asked, were the ideas of these ancient sun-worshippers as to the nature and character of their god? The most outstanding of all the qualities attributed to the sun-god by the Heliopolitan priests is his righteousness. The sun-god is not only represented as loving righteousness and truth and hating iniquity, but also it was said that he it was who "fashioned righteousness." Righteousness is so much a part of the god's being that he is said to live (*i.e.* feed) on it, just as Hapi the Nile-god is said to live on fish! This righteous god demanded righteousness in his worshippers also, and before the Osirianisation of the Egyptian conceptions of the life after death, a process which they underwent in the period between the end of the Old and the beginning of the Middle Kingdom (about 2475 to 2160 B.C.), the sun-god was regarded as the judge of the dead, in which capacity certain texts represent him as weighing righteousness in a balance, *i.e.* testing the righteousness of the dead.

Now the king of Egypt (in the first instance the king of Heliopolis) was thought to be, as we have seen, the embodiment of the sun-god. Accordingly, like his divine prototype he was supposed to be the upholder of righteousness, truth, and justice. But the close association of the king with the god not only associated the god's righteousness with the king: it also associated the kingship with the god. Thus the sun-god, who is represented in the myths as the first king of Egypt, came to be regarded as the prototype of all Egyptian sovereigns, the ideally righteous king, the pattern of all would-be righteous Pharaohs. In a literary composition of the Feudal Age, describing the miserable plight of Egypt under the rule of a weak Pharaoh, a sage contrasts the prevailing unhappy conditions with the state of affairs in that far-off golden age when the sun-god, the ideal king, ruled over Egypt. He speaks of the sun-god as "the shepherd (lit. herdsman) of all men, with no evil in his heart." "Where is he to-day?" he asks. "Does he sleep perchance? Behold his might is not seen!"

Purity, and particularly physical purity, was another attribute of the sun-god. Everything connected with him must, it was maintained, be pure, and only those who were pure could approach him. Consequently lustral washing was a marked feature of the sun-cult, no priest being able to enter the sun-temple (eventually any temple) to officiate until he had undergone purification. Even the sun-god himself is represented as washing or being washed every morning in some mythological lake or pool before appearing above the eastern horizon.

Now according to one conception, the sun-god was reborn every morning, having been born in the first instance, be it noted, out of the waters of the celestial ocean. Naturally enough, therefore, his daily rebirth came to be associated with his daily lustration, and he was supposed to be reborn every day at dawn as the result of washing or being washed in the waters of this or that sacred pool. In accordance with this conception, an early and important episode in the liturgy, which was celebrated every day at dawn in all Egyptian temples (in the first instance, of course, the Heliopolitan sun-temple), was the washing or sprinkling of the divinity's (originally the sun-god's) cultus-image with water, in imitation of the sun-god's supposed daily matutinal lustration.

The Heliopolitan king, the sun-god's embodiment, was, as already stated, his high-priest, and in this capacity he entered, or was supposed to enter, the sun-temple every day at dawn to celebrate the liturgy. Before he entered the god's presence he had, like every other priest, to undergo purification, but in his capacity of embodiment of the sun-god he was conceived of as reborn as the result of his ceremonial washing, just as was his divine prototype. As we shall see, the king was also regarded as the son of the sun-god, and was thus thought of as rebegotten as well as reborn through the agency of the lustral water, this being identified with the sun-god's own efflux, the very efflux with which he had brought into being his two children, Shu and Tefēnet. The king's lustral washing took place in an adjunct of the sun-temple, called the House of the Morning, so named on account of the very early hour at which this ceremony took place. The king not only underwent lustration in this chamber, but he was also robed, anointed, and crowned there, invested with the royal insignia, and apparently also presented with a light repast, after which proceedings he was ready to enter the temple to officiate.

The consort assigned to the Heliopolitan sun-god by his priests was Ḥathor, a goddess who was especially associated with music and dancing. The queen, as wife of the high-priest of the sun-god, was, in accordance with Egyptian custom, that god's high-priestess; moreover as wife of the embodiment of the sun-god she was considered to be the god's earthly wife, and so was identified with Ḥathor. Like her divine prototype she was associated with music, and it was her function to sing and rattle her sistrum while her husband, the high-priest, celebrated the liturgy.

A notable feature of the worship of Ḥathor was the performances of her musician priestesses, who were attached to her temple in large numbers. These performances consisted in dancing to the accompaniment of the rattling of sistra and the beating of single-membrane drums. Since Ḥathor was assigned to the sun-god as his wife, musician-priestesses were attached to his temple, and their dancing, singing, and playing thus became a feature of the sun-cult—eventually of all the solarised cults of Egypt. Over these musician-priestesses in the provincial temples presided the high-priestess, the wife of the high-priest, who, as inscriptions occurring in several temples explicitly state, was regarded as the wife of the god, and was as such identified with Ḥathor—the god himself being identified with the sun-god. The musician-priestesses attached to the great solar or solarised temple at the capital were, of course, presided over by the queen, the earthly counterpart of Ḥathor *par excellence*. These musician-priestesses of Ḥathor consciously impersonated Ḥathor in their performances, and are actually spoken of as Ḥathors. Thus not only the high-priestess was identified with Ḥathor, but the musician-priestesses over whom she presided were designated Ḥathors also.

Since the chief musician-priestess—at the capital the queen, or in the provinces the local high-priest's wife—was regarded as the god's earthly consort, the ordinary musician-priestesses were reckoned to be his concubines, in which connexion it is interesting to note that the Temple of Luxor, which was dedicated to the solarised Theban Amūn, was known as the Southern Ḥarīm of Amūn; so it was possibly the headquarters of that god's concubines.

Owing to the queen holding the position of wife of the sun-god, her son, the future king, naturally came to be regarded as the actual physical son of that divinity, the explanation of this wondrous happening being that the god had intercourse with the queen by incorporating himself in the reigning Pharaoh.

A brief description must now be given of an ordinary Egyptian temple, and some account of the ideas which the Egyptians entertained with regard to it, all of which will show effectually how preponderating was the influence of Heliopolis in all matters religious, and how complete was the process of solarisation which Egyptian temple-worship and all its accessories had undergone, certainly before the end of the Old Kingdom, possibly at a much earlier date.

A great ornamental gateway flanked by two towers, commonly called a pylon, admitted to an open court surrounded by a colonnade. Behind this court was the hypostyle or pillared hall, and behind it again, buried in profoundest darkness, lay the sanctuary, containing the cultus-image of the divinity to whom the temple was dedicated. In adjoining rooms were enshrined the images of the co-templar divinities. Yet other rooms served as store-chambers for the sacred utensils and vestments, or for the performance of special ceremonies.

Owing to the prevailing solar influence, Egyptian temples, certainly in early times and often later, were orientated east and west, so that the rising sun at the equinoxes might light up their dark interiors. Indeed, according to the current Egyptian conception, it was the sun-god before all others who dwelt in every temple, which was regarded as a small replica of heaven itself. Thus a favourite description of a temple is that it is "like heaven in its interior, while Rēʿ (the sun-god) rises within it."

Against the eastern face of either of the above-mentioned pylon-towers were erected two or four, sometimes even five, tall masts—four to ten in all—from the tops of which fluttered white, green, blue, and red flags. These towers themselves were equated with the two sisters Isis and Nephthys, who were regarded as a pair of midwives lifting up the newly-born sun into the sky every morning.

In front of the pylon there generally stood two obelisks, one on either side of the gateway. The obelisk, or rather the pyramidion on top, was closely connected with the sun-cult, being a replica of the sacred *benben*-stone in the temple at Heliopolis. This stone was the emblem of the sun-god, one of the forms under which he was worshipped, and on it he was said to have sat when he begat of himself the god Shu and the goddess Tefēnet.

Colossal statues of the royal founder or benefactor of the temple were often erected in front of the pylon beside the obelisks. Other statues of the king, representing him either in the guise of a worshipper or offerer, or as just standing or seated, were set up in various parts of the temple. Through the medium of these statues, which to the Egyptian mind were very closely connected with the person they represented (that person being regarded as immanent in them), the king could, according to the character of the statue, function perpetually either as worshipper or offerer, or else as the recipient of worship and offerings.

In the main sanctuary, and in the sanctuary of each of the co-templar divinities, was a shrine containing the cultus-image, which was as a rule quite small—sixteen inches to four feet in height—and made of wood. Sometimes the shrine was a monolithic naos set up against the back wall of the sanctuary, with a bronze frame inserted in front fitted with double doors. More often the shrine was in the form of a boat, which rested upon an altar-like stone pedestal, the place where it stood being designated "the great place." In the centre of the boat, covered with a veil, was a cabin containing the image. Poles were attached to these boats so that they might be carried in procession, the number of priests who supported them varying from eight to twenty-four, or even twenty-six. In the sanctuary of the Heliopolitan sun-temple there were two such boat-shrines, representing the morning- and evening-barque of the sun-god. The boat-shrine is undoubtedly of solar origin, for it was the sun-god in particular who was conceived of as sailing across the sky in a boat.

The sanctuary, or else the actual naos containing the image, is often designated "Heaven" or the "Horizon" in inscriptions, and one of the titles borne by the high-priest of the solarised Theban Amūn was "Opener of the Doors of Heaven in Elect-of-Places (Luxor)," it being the duty of the chief officiating priest to open the doors of the shrine or sanctuary at an early stage of the temple liturgy.

Every temple possessed its sacred pool containing the water used for purificatory purposes, and it is to be noted that this pool, for reasons that have been fully set forth above, seems always to have been associated with the sun-god.

Again, every temple down to the latest times possessed its vestry or House of the Morning, an adjunct, as has already been pointed out, of the ancient Heliopolitan sun-temple.

One of the clearest proofs of the complete solarisation of institutional religion in Egypt is to be found in the organisation of the priesthood, which at every temple was divided into four "watches," or, as the classical writers designated them, phylæ. These "watches" bear the names of the four quarters of a ship—the bow-, stern-, starboard-, and larboard-watch, names which mythological texts assign to the four watches into which the crew of the sun-god's ship was divided. It was evidently the Heliopolitan priests who were first divided into four watches bearing these names, for, as already stated, the sun-god was supposed to traverse the heavens in a ship and his priests may well have been regarded as his crew.

The liturgy itself consisted largely of a series of toilet-episodes, and thus closely resembled the ceremonial toilet of the Pharaoh in the House of the Morning, a resemblance due to the fact that both imitated the same performance, the supposed daily matutinal ablutions of the sun-god, the cultus-image of the divinity (originally the sun-god) being washed or sprinkled with water every day at dawn, as the god himself was believed to be. That the other toilet episodes in the temple liturgy—robing, anointing, crowning, etc.—were like those performed for the king, was due to the fact that the sun-god, for whom the rite was instituted, was himself regarded as a king—the divine prototype of all Heliopolitan kings. The chief officiant at the liturgy was supposed to be the Pharaoh, but it was of course impossible for the supreme head of the highly organised Egyptian state of historic times to function daily as high-priest, even in the temple at the capital, let alone in the countless temples scattered over the length and breadth of the land. His place was therefore taken by a deputy, the local high-priest, or some other member of the higher grade of the priesthood. In addition to the chief officiant a number of assistant priests took part in all the ceremonies, as certain representations clearly show.

The liturgy falls into three main divisions: (1) A series of pre-toilet episodes, among which were included the unbolting and opening of the sanctuary or naos doors, the sweeping of the sanctuary floor with a cloth or besom, preliminary fumigations with incense, the prostration of the celebrant, the chanting of the praises of the god, and the removal of the image from the shrine. (2) The lustral washing of the image, followed by a long series of other toilet performances. (3) The liturgy terminated with the presentation of a meal to the god, a lengthy and highly ceremonious proceeding. When the food- and drink-offerings had all been laid in order before the image—the heaped-up food offerings surmounted with bouquets of flowers and the wine-jars wreathed with garlands—the officiant extended his right arm and, bending his hand upwards in the prescribed manner, pronounced a formula beginning with the words "An offering which the king gives." The recitation of this formula was preceded by the burning of incense and the pouring out of a libation. The priest having next recited the formula of "Summoning the divinity to his repast," performed the act of consecration, by which each item of food and drink was finally made over to the divine banqueter. This act consisted in the king, or his deputy the priest, standing before what was to be offered, and four times stretching out over it or towards it a ceremonial baton called the *kherp*-baton, which he grasped in his right hand.

The last act of the officiant before he left the sanctuary was to remove all traces of his own and his assistants' footprints. This he did by sweeping the floor once more with a cloth or besom. The sanctuary door was then closed and bolted and a clay seal affixed to the bolts.

Before bringing this preliminary article to an end, it should be pointed out that music, vocal and instrumental, was a great feature of Egyptian worship—a much greater feature than may have appeared from what has already been said in connexion with the musician-priestesses. These priestesses, it would seem, headed by the god's earthly wife, the high-priestess, rattled their sistra, beat single-membrane drums, and chanted hymns in the divinity's praise, all the time that the chief officiant and his assistant priests were executing the various ritual acts, while male musicians also bore their part in the proceedings, singing, and playing on flutes and stringed instruments.

The following and concluding article will deal with the monotheistic Aton-religion instituted by Ōkhnatōn, and so enthusiastically practised and propagated by him at his capital, El-Amarna, in Middle Egypt.

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The Photosynthesis of Plant Products.[1]

By Prof. I. M. HEILBRON.

DESPITE the enormous strides that have been made by chemists during the last decades in the elucidation of many classes of plant products and the actual synthesis of individual members, the methods hitherto employed in the laboratory are so essentially different from those carried out by the plant that the synthetic processes of the living organism have come almost to be regarded as something fundamentally apart from those of the laboratory. The investigations on photosynthesis now being carried out in Liverpool by Prof. Baly and myself, although as yet of a quite preliminary nature, have, in my opinion, already shown that such a conclusion is entirely unwarranted and that the key to the problem of plant syntheses is to be found in the study of the energy transformations involved in the primary reaction wherein the plant brings about the fixation of atmospheric carbon dioxide. Apart from the purely academic interest of the subject, the problem of photosynthesis demands the attention of the community as a whole, for, with the elucidation of the reactions involved, the economic aspect of the question must inevitably become more prominent, and practical results of the greatest value to mankind may conceivably accrue.

The work of the earlier investigators on the subject has led to the formulation of certain definite conclusions. Thus, it has been proved beyond question that photosynthesis takes place in the green leaf of the plant and that, under natural conditions, assimilation apparently consists in the absorption of carbon dioxide by means of the chlorophyll contained in the chloroplasts and its deoxidation and condensation therein, in the presence of water and sunlight, to sugars. It is obvious that, in order to obtain any satisfactory explanation of the rôle played by the chlorophyll, its constitution, and above all its reactions, must be known. The first advance in this direction is due to von Baeyer,[2] who suggested that the initial product of assimilation was formaldehyde, which then further condensed to form carbohydrates. This hypothesis was rapidly put to the test in two directions. Innumerable attempts have been made to prove the presence of formaldehyde in the green leaf itself, but in every case where this appeared to be established its formation could as readily be explained as being derived from sources other than assimilation. As regards the production of formaldehyde from carbon dioxide *in vitro*, this has actually been carried out in numerous ways,[3] none of which, however, are directly comparable with the conditions existing in the plant itself. The most detailed work in this connexion is that of Moore and Webster,[4] who showed that, under the action of light, formaldehyde was readily produced in solutions of carbonic acid containing colloidal uranium hydroxide or ferric hydroxide. As a result of these experiments, Moore concluded that, although chlorophyll had come to be universally regarded as the fundamental agent for photosynthesis, the evidence was purely inferential, and it was more probable that the synthesis of formaldehyde in the presence of sunlight was actually due to the inorganic iron present in the colourless portion of the chloroplast.

Recent research shows this hypothesis to be incorrect. Iron is undoubtedly essential to plant life, just as it is to animal life, and its function seems to be closely associated with chlorophyll formation. Leaves starved of iron suffer from chlorosis but, in these, photosynthesis does not take place, and there can be little doubt that the real catalyst for the assimilation reaction is chlorophyll. Our knowledge of the constitution of this interesting and highly complex pigment is mainly due to the work of Willstätter and his collaborators,[5] who have established the fact that the following four pigments are invariably present in the green leaves of all land plants: Chlorophyll A, $C_{55}H_{72}O_5N_4Mg$, chlorophyll B, $C_{55}H_{70}O_6N_4Mg$, carotin, $C_{40}H_{56}$, and xanthophyll, $C_{40}H_{56}O_2$. From an exhaustive study of the assimilation of carbon dioxide by the green leaf, Willstätter[6] has been able to arrive at certain very important generalisations. He has found that in all cases the oxygen evolved is absolutely equivalent to the carbon dioxide absorbed, which definitely proves that formaldehyde must be the first product, since the primary formation of such other substances as have from time to time been suggested would necessitate a volume ratio greater than 1 : 1. Further, from the results of experiments carried out both in the leaf and *in vitro*, he has been able to show that, although chlorophyll is inactive to dry carbon dioxide, it is nevertheless capable of combining with carbonic acid to form a labile addition compound. He concludes that this latter, by the absorption of light energy, is rearranged into a formaldehyde peroxide complex from which, by means of enzyme action, formaldehyde is liberated, oxygen evolved, and chlorophyll regenerated.

[1] Substance of lectures delivered at the Royal Institution on February 1 and 8.
[2] Ber. (1870) 3, 68.
[3] Usher and Priestley, Proc. Roy. Soc. (1906) B, 77, 369.
[4] Proc. Roy. Soc. (1913) B, 87, 163.
[5] Willstätter und Stoll, "Untersuchungen über Chlorophyll," Berlin, 1913.
[6] Willstätter und Stoll, "Untersuchungen über die Assimilation der Kohlensäure," Berlin, 1919.

This work still leaves much unexplained and in no way helps to disentangle the paradox that whereas, on one hand, formaldehyde must actually be produced, it nevertheless does not exist in the leaf. Nor does it afford an explanation of the rapid synthesis of either the disaccharides, such as cane-sugar, or of storage starch. Again, it is curious that, if the reactions are actually those specified by Willstätter, Nature should, apparently by caprice, invariably ensure the presence of the two chlorophyll components and also the carotinoid pigments, when one chlorophyll individual would by itself be sufficient. It would seem more probable that the four pigments are present because each has an absolutely definite rôle to play in the mechanism of assimilation. This suggestion is strongly supported by a consideration of the striking oxygen values existing between the two pigment classes, these being in strict agreement with the amount of oxygen liberated in the photosynthetic operation.

Returning now to the consideration of the primary synthesis wherein carbonic acid is deoxidised to formaldehyde, this reaction is a highly endothermic one, impossible to realise under the conditions commonly employed in the laboratory. On the other hand, carbonic acid is able to absorb light of very short wavelength ($\lambda = 200\ \mu\mu$), and, if exposed to light of this frequency, the formation of formaldehyde, without the agency of any catalyst, can readily be demonstrated under these purely photochemical conditions. Moreover, in the presence of a suitable basic coloured substance, such as malachite green, with which the carbonic acid can combine loosely, the formation of formaldehyde can be demonstrated in visible light, the malachite green acting as a photocatalyst for the reaction.[7]

Carbohydrate Production.

The formation of sugars on exposure of aqueous solutions of formaldehyde to ultra-violet light was demonstrated by Moore and Webster.[8] These observations have been fully confirmed, and it has been found that the wave-length of light which brings about this reaction ($\lambda = 290\ \mu\mu$) is photochemically distinct from that required for the synthesis of formaldehyde itself. In our earlier experiments in Liverpool, it was considered that the photosynthetic formation of carbohydrates had to take place in two distinct stages, but, as will be explained below, later experiments have shown that this interpretation was incorrect, the actual process being simpler. The formaldehyde molecule, when first produced by photosynthesis from carbon dioxide, exists in a highly reactive phase, identical with that obtained when ordinary formaldehyde is photochemically activated. This type of formaldehyde we have designated "activated formaldehyde," and it is this which must be photocatalytically produced through the agency of the chlorophyll, and immediately condenses to sugars, for, as is well known, ordinary formaldehyde has no such property. It follows from this that the formaldehyde detected in the carbonic acid experiments cannot have been a direct product of photosynthesis, but must have resulted from a subsequent decomposition of photosynthesised sugar. That carbohydrates readily yield formaldehyde under the influence of short wave-length light has been proved experimentally, and thus the detection of formaldehyde in any photochemical operation may be regarded as sure evidence of photosynthesis.

The investigation into the nature of the sugars formed by the photochemical activation of formaldehyde is still being carried out, but we have been able to prove conclusively that the condensation leads to the production of hexose sugars alone. This fact affords a ready explanation of the formation of disaccharides and starches, for the freshly photosynthesised hexose molecule must exist in a highly reactive phase, and consequently further condensations will inevitably take place.

Nitrogen Assimilation.

The problem as to the origin of the many classes of nitrogen compounds occurring in the vegetable kingdom is one fully equal in importance to that of the formation of carbohydrates, but although many have speculated on their possible synthesis, little definite evidence has hitherto been adduced to account for their production. The questions which have to be considered in this connexion are, first, under what conditions and in what state does the nitrogen enter the plant, and secondly, is the fixation process a photosynthetic reaction? With regard to the manner in which nitrogen is supplied, the general method would appear to be that it passes into the roots in the form of nitrates, or possibly ammonium salts, present in the soil. In addition to the introduction of nitrogen in this manner, Moore[9] has found that in the case of unicellular algæ, providing abundant carbon dioxide is present, elemental nitrogen from the atmosphere can be absorbed and directly utilised. This discovery, which is of quite exceptional interest and fully corroborates Jamieson's[10] earlier investigations, is still further supported by the recent observation of Lipman and Taylor,[11] who claim to have proved that ordinary wheat is able to assimilate up to 20 per cent. of its total nitrogen content in the form of free nitrogen.

It was noted by Schimper that nitrites are invariably present in the green leaf when kept in the dark, but that they rapidly disappear on exposure to light, and the deduction may thus be drawn that these are the active substances employed in the nitrogen fixation. The direct assimilation of atmospheric nitrogen in no way invalidates this conclusion, for there can be little doubt that the free nitrogen will readily react with the nascent oxygen formed during the photolysis of the carbon dioxide to yield oxides of nitrogen.

With these facts in mind, exhaustive experiments are now being carried out in Liverpool on the interaction of nitrates with activated formaldehyde. It has been found that under all conditions the primary reaction product is formhydroxamic acid,[12] $\begin{matrix} H \\ HO \end{matrix}\!\!>\!C{=}NOH$, a substance which had previously been obtained by Baudisch[13] in his pioneer work in this field. The formation of formhydroxamic acid takes place only in the presence of activated formaldehyde, no trace of it being found

[7] Baly, Heilbron, and Barker, Jour. Chem. Soc. (1921) 119, 1025.
[8] Proc. Roy. Soc. (1918) B, 90, 168.
[9] Moore and Webster, Proc. Roy. Soc. (1920) B, 91, 201; (1921) B, 92, 51.
[10] Reports Agricultural Research Association, Aberdeen (1905–1911).
[11] *Science*, 1922, November 24.
[12] Baly, Heilbron, and Hudson, Jour. Chem. Soc. (1922) 121, 1078.
[13] Ber. (1911) 44, 1009.

when solutions of ordinary formaldehyde and potassium nitrate are allowed to remain in the dark. Now, as this acid is also produced on passing carbon dioxide through aqueous solutions of either potassium nitrate or potassium nitrite exposed to ultra-violet light, the requisite proof is furnished of the statement that the freshly synthesised formaldehyde must be beyond doubt activated formaldehyde. These experiments have led us to the conclusion that formhydroxamic acid marks the initial stage in the phytosynthesis of nitrogen compounds. This view is further substantiated by the fact that, on exposure to ultra-violet light, formhydroxamic acid rapidly reacts with activated formaldehyde to form various other products, many of a complex nature, whereas in the absence of light no such change occurs.

In the course of these experiments, other facts of great importance have been noted. It has been found that by employing excess of nitrite no reducing sugars whatsoever are formed, but that if the activated formaldehyde is in excess of that utilised by the nitrite, the presence of reducing sugars can be readily detected. These experiments prove that the synthesis of nitrogen compounds by the interaction of nitrites with activated formaldehyde takes precedence over the condensation of the latter to carbohydrates. In the plant, however, as the amount of nitrogen actually fixed is small in comparison with the total carbon assimilated, both carbohydrate and protein formation take place simultaneously.

As regards the type of substances which have been classified up to the present, conclusive proof of the formation of α-amino acids has been obtained, and thus a definite intermediate stage in protein production has been reached. At least four distinct types of α-amino acids have so far been isolated in the form of their copper salts, and it is certain that at least one of these is a complex acid, possibly analogous to histidine.

In addition to the synthesis of amino acids, nitrogen bases, such as methylamine, pyridine and piperidine, have been isolated. Substances of alkaloidal character are also formed in the reaction, but as yet we have been unable to separate any one alkaloid in sufficient quantity for detailed investigation.

Another line of attack, at present in active progress, is the study of the action of ammonia on photochemically activated formaldehyde. Here again it has been ascertained that, whether one starts from carbon dioxide and ammonia or from ordinary formaldehyde and ammonia, identical products are obtained. Moreover, although under normal conditions interaction only occurs under the influence of light of very short wavelength, by employing ammoniacal copper solutions the reaction can be photocatalysed to take place in visible light. In all cases the presence of methylamine, pyridine or piperidine, can again be recognised after comparatively short exposure to light, and by extending the period of illumination to several days the presence of alkaloids can also be experimentally confirmed.

In this case it has been possible to isolate an individual alkaloid in sufficient quantity to enable numerous qualitative and physiological tests to be carried out. Despite the difficulties of identification of these substances, the experimental evidence obtained would seem definitely to indicate that this photosynthetic alkaloid is coniine.[14]

In conclusion, I would direct attention to some general deductions naturally arising from the work in hand. According to the views now put forward, it necessarily follows that, both in the case of the photosynthesis of carbohydrates and also in that of the phytosynthesis of nitrogen products, the whole centre of activity must be contained in the green leaf itself. As to the manner in which translocation from this point to other portions of the plant is brought about, it may be suggested that, as the synthesis of active hexoses takes place concurrently with the production of nitrogen compounds, the conditions are especially favourable for glucoside formation. In this way a method would be found for the easy removal of insoluble materials from the leaf.

Finally, I would emphasise the point that in regard to the work being carried out by Prof. Baly and myself, our only claim is that we consider it by no means impossible to reproduce in the laboratory processes strictly analogous and directly comparable with those taking place in the plant. The chemistry of photosynthesis is new and strange, and as such will undoubtedly be viewed with a certain degree of scepticism, for the inherent conservative spirit among even scientific investigators tends to react against any new order of things. Photosynthesis is in the main the chemistry of one single substance—formaldehyde. The whole process is dependent on energy supplied from the sun and made available through the wonderful activity of the pigment chlorophyll.

[14] Baly, Heilbron, and Stern, Jour. Chem. Soc. (1923) 123, 185.

Obituary.

Lord Carnarvon.

We much regret to record that Lord Carnarvon died at Cairo on April 5, from the effects of pneumonia, supervening on erysipelas and blood-poisoning, the result of a bite on the cheek by an insect, presumably a mosquito.

Lord Carnarvon was born on June 26, 1866, and was the son of the fourth Earl, whom he succeeded in 1890. He was educated at Eton and Trinity, Cambridge. He travelled extensively, won a reputation as a big-game shot, and was interested in the Turf. He was a great connoisseur and collector of illuminated books, manuscripts, and medals, as well as of antiquities of fine workmanship and small size. Of the last-named he had a remarkable and, in some respects, a unique collection. It is, however, in connexion with the study of the history and antiquities of Egypt that Lord Carnarvon's name will be handed down to posterity. In 1906 he, in association with Mr. Howard Carter, formerly inspector under the Egyptian Antiquities Department, began excavations, chiefly on the north side of the Assassif Valley near Der el Bahari, which resulted in the discovery, among other finds, of the tomb of the "King's Son" of Dynasty XVIII. in 1908 and, in 1910, of a rich tomb of Dynasty XII. The results of these early excavations were embodied in Lord Carnarvon's "Five Years' Excavations in Thebes," which appeared in 1912.

After the War, Lord Carnarvon began excavations in the Valley of the Kings, a site which had rewarded the excavations of Mr. Theodore M. Davies with some remarkable finds. No striking results were obtained until November 5 last, when Mr. Carter discovered the tomb of King Tutankhamen—a discovery unique in the annals of archæology. The interest of the objects taken from the tomb, remarkable both in their number and character, grew from day to day, and culminated on February 17, when the opening of the inner chamber revealed the shrines in which it is expected that the body of the king will be found. Work was then closed for the season.

It adds a note of tragedy to Lord Carnarvon's death that he will not be present when the opening of the innermost shrine crowns his labours, but his name will always be honoured as one who added a vast store to our knowledge of the civilisation of Ancient Egypt.

Dr. C. I. Forsyth Major, F.R.S.

Dr. Charles Immanuel Forsyth Major, who died at Munich on March 25, aged seventy-nine, was born in Glasgow, of Scottish parents, but removed when an infant to Constantinople, and lived for most of his life abroad. He was educated in Switzerland, Germany, and Italy. Graduated Doctor of Medicine in Basle in 1868, and began his career as a medical practitioner in Florence.

Dr. Major was, however, always interested in natural history, and his association with Rütimeyer in Basle led him to become an enthusiastic student of fossil mammals. While occupied with his professional duties in Florence, he took every opportunity of collecting and examining the mammalian remains found in the superficial deposits in the valley of the Arno, and from 1872 onwards he published in Italy a series of small papers on these remains, describing and discussing them in a more exhaustive manner than had previously been attempted. He summarised his results in the Quarterly Journal of the Geological Society of London in 1884, pointing out that the later Pliocene mammals were all distinguishable from those of the early Pleistocene when fossils were studied in detail. At the same time he published valuable memoirs on the dentition of rodents from the Bohnerz of Switzerland and South Germany (*Palæontographica*, xxii., 1873), and on the dentition of the early true horses (*Abhandl. Schweiz. Paläont. Ges.*, 1877–80).

About 1886 Dr. Major abandoned his medical practice, and began to devote himself entirely to scientific research. With the help and encouragement of his Swiss friend, M. W. Barbey, he made a thorough exploration of the Pliocene accumulation of mammalian bones in the island of Samos, and brought back a great collection, of which part was presented by M. Barbey to the Collège Gaillard at Lausanne, and the other part was purchased by the British Museum. In 1889 Dr. Major made another important collection of mammalian remains from a Pliocene torrent-deposit at Olivola in the Carrara mountains in Italy, and this was also purchased by the British Museum. Dr. Major followed his collections to the British Museum, and was temporarily employed there in cataloguing the fossil mammals until 1909. While thus occupied he published a valuable series of papers in London. He also arranged to prepare a Catalogue of Fossil Rodentia for the British Museum, and a large monograph of the Samos Mammalia, which unfortunately were never produced.

In 1893 Dr. Major contributed his important memoir on the skull of a giant lemur, Megaladapis, from a cavern in Madagascar, to the Philosophical Transactions of the Royal Society, and the novelty of this discovery led him to plan an exploration of the caverns and marshes of Madagascar. With the aid of a government grant from the Royal Society, he visited Madagascar in 1894–95, and brought back an important collection of fossil mammals and birds, which is also now in the British Museum. On these fossils he wrote several descriptive papers.

In his later years, however, Dr. Major found increasing difficulty and diffidence in preparing his results for publication, although his researches were pursued with accustomed diligence. Much of his valuable work on rodents and on the relationship between the fossil Samotherium, which he discovered in Samos, and the existing okapi of the Congo Forest, is thus unfortunately lost to science. Dr. Major was elected a fellow of the Royal Society in 1908, and about the same time was awarded a small Civil List pension. He then returned to the Mediterranean region which had interested him for so many years, and spent most of the remainder of his life in Corsica. He still continued to collect and study mammalian remains, chiefly from the caverns and rock-fissures of Corsica, but he now ceased to do more than make manuscript notes.

A. S. W.

Mr. E. W. Vredenburg.

Geology has lost a cultured worker by the death of Ernest Watson Vredenburg, who passed away on March 12, at the age of fifty-three. His death was probably hastened by the constant and now painfully verified foreboding that he might never be able to finish the great task which he had undertaken of revising the Tertiary palæontology of the Indian region. We have had occasion at times to notice some of the numerous instalments which he has published during the past few years in the Records of the Geological Survey of India; they and other papers now in the press were intended to prepare the way for a comprehensive monograph which he hoped would justify his reason for differing from his colleagues on some questions of stratigraphical correlation; but the burden was too great for that hyper-sensitive, artistic, and retiring nature which tended to keep him apart from his colleagues, who nevertheless appreciated his deep learning, unrelenting industry, and tenacious adherence to independent views.

Mr. Vredenburg, who was half French in race and wholly so in upbringing, graduated at Paris in Science and Letters before entering the Royal College of Science and School of Mines, where he took a double associateship, in geology and mining, before joining the Geological Survey of India in 1895. He spent the first part of his official work on the relatively uninteresting unfossiliferous rocks of Central India, and did not get an opportunity of discovering his main bent till his transfer to Baluchistan, the geological features of which he revised and summarised in 1910. There and in the adjoining regions of Sind he became deeply interested in the stratigraphy and palæontology of the

Lower Tertiary system, extending his work afterwards to the younger beds in the Burma oil-fields.

South Kensington students will remember him as a brilliant pianist who would have had a distinguished position in the musical world if he had not concentrated on the palæontology of India. During his early days in India he showed a tendency to become engrossed in archæological interests until palæontology claimed him first as a devotee and finally as a victim.

Count Fernand de Montessus de Ballore.

The small band of seismologists has suffered a serious loss through the death of M. de Montessus de Ballore. Born in 1851, he was trained at the École Polytechnique, where he was a fellow-student of Marshal Foch. In 1881 he was sent as chief of a military mission to San Salvador. There he became interested in the frequent earthquakes of the Central American republics, and he continued his seismological studies on his return to Paris as Directeur des Études at the École Polytechnique. In 1907 he was appointed director of the earthquake-service in Chile, a service which, through his efforts, became one of the first rank.

De Montessus will be chiefly remembered and valued for his studies on the distribution of earthquakes. His great work on "Géographie Séismologique," which occupied his leisure for twenty-four years, was published in 1906. Few men could be so well qualified as he for an undertaking so vast, for he had a good knowledge of six foreign languages. Having collected records of nearly 160,000 earthquakes, he showed that seismic regions follow the principal lines of relief, that, in a group of unstable regions, the most unstable are those of the greatest relief, and that more than 90 per cent. of the earthquakes occurred along two narrow zones occupying great circles of the earth, which he called the Mediterranean circle and the circum-Pacific circle. In 1907 his second work, "La Science Séismologique," appeared and at once took its place as an authoritative treatise.

Besides these two volumes and a small popular book published in 1911, de Montessus was the author of many memoirs. One of the latest was a bibliography of seismology containing the titles of more than 9000 books and papers. In the preparation of these works, he had collected a library, perhaps the most extensive of the kind in existence. This was bought a few years ago by the late President J. C. Branner, and was presented by him to the University of California. C. D.

Prof. M. Abraham.

The issue of the *Physikalische Zeitschrift* for February 1 contains an obituary notice of Prof. Max Abraham by Profs. M. Born and M. v. Laue. He was born at Danzig in 1875 and studied under Planck at Berlin. After graduating he became Planck's assistant, and in 1900 privatdozent at Göttingen. For a short time in 1905 he acted as professor at the University of Illinois, and, after his return to Göttingen, was in 1909 appointed professor of theoretical physics at Milan. The War ended this, and he held temporary posts till last year, when he was appointed professor of theoretical mechanics at Aix-la-Chapelle. Illness prevented him commencing duties there, and he died of tumour on the brain on November 16, 1922. He was well known in this country for his book "Theorie der Elektrizität," for his articles on vectors and on electromagnetic waves in the "Mathematische Encyklopädie," and for his papers on the dynamics of electrons, all giving evidence of a clear and logical mind.

We regret to learn from Australia of the death, at the end of January, of Dr. J. L. Glasson, at the age of thirty-four years. Dr. Glasson was a student of the University of Adelaide, where he worked under Sir William Bragg, and from that University he received his doctor's degree. He succeeded in winning a travelling research scholarship of the Exhibition of 1851, and with it came to this country. He entered Gonville and Caius College, Cambridge, in 1909 as an advanced student, and, going to the Cavendish Laboratory, did valuable research work under Sir J. J. Thomson. In 1912 he was appointed lecturer in physics in the University of Tasmania, Hobart, and while there he did valuable work for the Electrolytic Zinc Co. and for the Tasmanian Carbide Co. This post he resigned in 1919, returning to Cambridge for research for a couple of years, after which he accepted an appointment as lecturer in physics in the University of Melbourne, which he held at the time of his death.

The sudden death from angina pectoris on March 15 of Mr. G. E. Bullen, Curator of the Herts County Museum at St. Albans, is announced. Among the smaller museums in the country there can be few which have been raised to such a pitch of excellence, and this has been due entirely to the whole-hearted devotion and enthusiasm of Mr. Bullen during the past twenty years. A considerable extension and rearrangement of the collections has recently been completed, and, especially on the archæological side, the museum is now a model of what a local museum should be, the clear demonstrative labelling of the exhibits being a special feature. Mr. Bullen's work had been for some time carried on in defiance of indifferent health, and his death at the early age of forty is a great loss.

The *Chemiker Zeitung* of March 17 announces the death in the beginning of March of Prof. Robert Scheibe, formerly professor in the Academy of Mines, Berlin, and later active in South-west Africa and Bolivia. In the issue of March 15 the death on March 10 of Prof. Ernst Salkowski, since 1880 director of the chemical side of the Berlin Pathological Institute, is announced. Prof. Salkowski was born on October 11, 1844, in Königsberg, and at first worked with Virchow. His researches covered a wide field in physiological chemistry.

We regret to announce the following deaths:

Dr. H. H. Stock, professor of mining engineering in the University of Illinois since 1909, on March 1, aged fifty-seven.

Dr. John Venn, F.R.S., president of Gonville and Caius College, Cambridge, and for many years lecturer in logic and moral philosophy in the University, on April 4, aged eighty-eight.

Mr. S. H. Wells, director-general of the Egyptian Department of Technical, Industrial, and Commercial Education since 1907, on March 28, aged fifty-seven.

Current Topics and Events.

With this issue appears the first of a series of supplements which it is proposed to publish from time to time dealing descriptively with subjects of wide scientific interest. The present supplement is devoted to a discourse delivered at the Royal Institution on March 2 by Dr. G. C. Simpson, director of the Meteorological Office, and it provides in a convenient form a synopsis of existing knowledge of common meteorological phenomena. The method of dealing with the subject is characteristic of the present-day physicist, and it is essentially interesting. Saturation and relative humidities are somewhat fully described, and this is followed by a discussion of condensation at temperatures above the freezing point. It is of interest to note that the number of nuclei present in the air varies from a minimum of about 100 per c.c. to 100,000 or 150,000 per c.c. at times in cities such as London and Paris. Condensation nuclei are formed in various ways, one being the household fires and factory chimneys which produce large quantities of nucleus-forming material, chiefly sulphurous oxide. In England something like 5000 tons of sulphur are burnt each day in coal fires, giving enough sulphur products to pollute the atmosphere of the whole of Great Britain. Haze and mist, though so much alike in appearance, appear to be fundamentally different, haze owing its origin to foreign matter and a small amount of water, while mist is due to an actual precipitation of water from vapour to liquid. On the other hand, there appears to be no fundamental difference between mist and fog, fog is generally only a dense mist. Above the fog temperature inversion prevents all upward motion of the air and the smoke made by large towns is kept fairly stationary and within a few hundred feet of the ground. Clouds, rain, thunderstorms, hail, snow, and other aspects of weather are so often topics of conversation that Dr. Simpson's authoritative discourse upon them will be welcomed by all scientific readers.

The nomination of Sir David Bruce as president of the British Association for the meeting in Toronto next year is a well-deserved honour which will be gratifying to the many friends and admirers of this distinguished scientific investigator. Sir David belongs to the Royal Army Medical Corps, and early in his career made a name for himself by cultivating the *Micrococcus melitensis* and establishing its causative relationship to Malta fever by reproducing the disease in monkeys. Later, in 1904, he was the leader of the Royal Society's Malta Fever Commission, which made the important discovery that fifty per cent. of the goats in Malta were infected and ten per cent. of them excreted the micrococcus in their milk. Within a year of prophylactic measures based on this fact being put in force, the cases at Malta fell to one-tenth of the former numbers, and since that time the Navy has been practically rid of one of the main causes of sickness in its personnel. Of still greater interest and importance are Sir David's patient and well-thought-out researches on the greatest obstacle to the civilisation of tropical Africa, tsetse-fly disease of animals and man. His demonstration of the *Trypanosoma Brucei* as the cause of the fatal tsetse-fly disease of cattle and horses in 1894 paved the way for his demonstration in 1903 that "sleeping sickness is, in short, a human tsetse-fly disease," by a wonderfully well conceived and worked-out experiment carried out as leader of a series of Royal Society Commissions working in Africa over a number of years. The etiology of two of the most important tropical fevers was thus elucidated by his investigations, with widespread results. Sir David is characterised by the thoroughness of his work and the intuition he has always brought to bear on every problem he has tackled. He is very fortunate in his helpmeet, Lady Bruce, who has shared in both the hardships and the scientific work of his many African expeditions.

Fifty years ago, on April 18, 1873, Justus von Liebig died at Munich at seventy years of age. In 1824, at the early age of twenty-one, he began his career as professor of chemistry at Giessen and he devoted the first twenty years of his academic work to researches in the field of organic chemistry and in developing and perfecting practical laboratory instruction. The results of these labours quickly met with general recognition, and on his first visit to England Liebig was referred to by Faraday, at the meeting of the British Association at Liverpool in 1837, as one of the greatest of living chemists. Great difficulties had to be overcome by Liebig when he began to extend his theoretical and practical work to biological problems. In 1840 he published "Organic Chemistry as applied to Agriculture and Physiology," and in 1842 "Animal Chemistry, or Organic Chemistry as applied to Physiology and Pathology." The doctrines of the nutrition of plants and animals contained in these epoch-making works were at first rejected by chemists, physiologists, and agriculturists, but most of them were established in the course of the following years. Liebig's view that plants build up their organic parts exclusively from the carbon dioxide of the air and the water contained in the atmosphere and the soil, and that in intensive agriculture the mineral substances, especially potash, phosphoric acid salts, and nitrogen compounds, must be supplied to the soil in the form of artificial fertilisers, in addition to natural manure, was first accepted in England. After Liebig had modified his original opinion that the artificial fertilisers must be fairly insoluble in order not to be washed away by the rain, having recognised the extent to which the soil is capable of absorbing these substances, his doctrine of artificial fertilisation was generally accepted and forms the foundation of modern agriculture. In 1864 and 1865 Liebig wrote, at the request of the Lord Mayor of London, important papers on the utilisation of the sewage of London. Other widely-known publications are those on meat extracts, baking methods, soup for infants, silver mirrors, etc. Liebig gave a popular exposition of his views in his "Familiar Letters on Chemistry," a work from which many students of science have derived interest and inspiration.

The season's excavations at Ur of the joint expedition of the British Museum and the University of Pennsylvania closed early in March. The chief results were described by Mr. C. Leonard Woolley in a lecture, reported in the *Times* of April 2, which he delivered at Bagdad before leaving for England. The excavations were made in a walled enclosure, resembling a citadel, within the walls of the city, in which the most prominent building was a *ziggurat* of four stories, the tower of the Temple of Nanna, the Moon god, completed about 2250 B.C., and coated with blue glazed bricks by Nabonidus about 550 B.C. One of the most interesting finds was a headless diorite statue of Eannatum, King of Lagash about 2900 B.C., which may have been a trophy of war. From its earliest beginnings, possibly in 3600 B.C., until it was altered by Nebuchadnezzar in about 600 B.C., the plan of the Temple remained unchanged. The find of a golden statue in a small temple at the foot of the tower indicates that this monarch introduced a change in ritual, to which reference is made in the book of Daniel, and brought the god from the seclusion of the sanctuary out into the open to be an object of public worship and veneration.

A question agitating workers in several branches of science at the present day rather more intensely than usual is the furnishing of an adequate guide to the growing volume of published work. The lapse of the International Catalogue and the great increase in the costs of production have made the situation acute. It has long been recognised that there is a vast amount of overlap and of wasted effort, and that, if only the various societies and publishing bodies would combine, they could provide a better service at less cost. This was the line followed by Dr. J. R. Schramm, of the National Research Council, Washington, in a recent lecture on the indexing of biological literature (*Science*, November 3, 1922). He held up *Chemical Abstracts* as the example to be followed, and considered that the Federation of American Biological Societies, to which we have previously referred, could produce a similar *Biological Abstracts*, equally complete, at an annual expenditure per member of 6 to 8 dollars. Dr. Schramm, it will be seen, believes that abstracts are what the workers want. Prof. Cockerell, in his comments on Dr. Schramm's proposals (*Science*, January 5, 1923), seems to prefer an analytical index, such as is furnished by the "Zoological Record." We agree with Prof. Cockerell; but, apart from that, the question is: Will a sufficient number of individuals be prepared to pay? The experience of the "Zoological Record" suggests that they certainly will not. This, however, may in part be due to the existence of the many competing, though less complete, abstracts and indexes, and in part to the ignorance and inertia of the workers. If, not only the American societies, but also the biological societies of the whole world, would federate for this purpose, so that the proposed *Record* or *Abstracts* were virtually the only one in existence, and were thus inevitably brought before each individual worker, then success would be assured. But that "if" implies the suppression of vested interests and of the nationalism which hampered the International Catalogue.

The theory of the tides is a very strong source of attraction for a certain group of unscientific speculators. One of the latest of these to put his ideas into print is Mr. Evan McLennan, of Oregon, from whom we have received a pamphlet entitled "Nature Notes, Critical and Constructive." After betraying a complete misunderstanding of the theory of the tide-generating force on the principle of gravitation, he remarks, "It would, quite probably, be regarded as a far greater violation of the principles of science to question the theory of gravitation than to swallow the inconsistency," and "Of the forty federal institutions established by our own Government alone for the purpose of scientific research and the increase and diffusion of knowledge, and of the more than 1500 investigators paid from the public treasury to do this work, there is in all probability not one who could be induced by an outsider to give the slightest attention to any vital criticism of the Newtonian theory of gravitation." We can assure Mr. McLennan that in his own country alone there is a large number of scientific men who would enthusiastically give their attention to any real inconsistency in the accepted theory of gravitation.

The Corn Sales Act came into force on January 1, so that it is no longer possible for buyer and seller of corn in Great Britain to misunderstand each other as to the particular kind of stone in which a transaction had been conducted. All such transactions must now be in cwts. of 112 lb. The Union of South Africa has, according to the March issue of the *Decimal Educator*, adopted the cwt. of 100 lb., so that the same kind of difficulty is likely to be felt in dealings between South Africa and this country as we have just avoided here with regard to corn. In both cases the Decimal Association advises the use of the 50-kilogram standard, which is approximately 110 lb. In the same way, to overcome the difficulty of the American gallon being only about five-sixths of the British gallon, the Association and the Metric Association of America recommend the introduction of the litre for all trade in liquids. With regard to our coinage, the Decimal Association is concentrating its efforts on the introduction of a high-value penny, of which 10 would go to a shilling, and the withdrawal of the threepenny-piece. In place of the latter a double-penny nickel coin would be issued. It is not proposed that new penny coins should be issued.

The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Westminster, on Thursday and Friday, May 10 and 11. The Bessemer medal will be presented to Dr. W. H. Maw, and the award of the Andrew Carnegie research scholarship for 1923 will be announced.

Twenty-four papers will be presented during the meeting, and their subjects will be announced in the Diary of Societies in Nature.

The May lecture of the Institute of Metals for the present year will be delivered by Dr. W. Rosenhain at 8 o'clock on Wednesday, May 2, at the Institution of Mechanical Engineers. The subject will be "The Inner Structure of Alloys."

The Hansen prize for distinguished microbiological work has been awarded this year by the committee of Danish trustees to Dr. E. J. Allen, director of the Marine Biological Association's laboratory at Plymouth, for his experimental researches in marine microbiology. It will be remembered that this award, to which we referred in our issue of February 3, p. 156, consists of a gold medal and a sum of 2000 kroner. Dr. Allen has been invited to visit Copenhagen to receive the medal and to deliver a lecture on his work on May 1.

A well-preserved rib of the gigantic dinosaur, *Cetiosaurus leedsi*, obtained by the late Mr. Alfred N. Leeds from the Oxford Clay near Peterborough, has just been added to the other remains of the skeleton exhibited in the geological department of the British Museum (Natural History). The rib measures six feet in length, and is remarkable for its slenderness.

The three lectures of the series on physics in industry arranged by the Institute of Physics last year will be published shortly in the series "Oxford Technical Publications." The fourth lecture of the series, entitled "The Application of Physics to the Ceramic Industry," will be delivered by Dr. J. W. Mellor on Wednesday, May 9, at 5.30 p.m., at the Institution of Electrical Engineers. Other lectures will be delivered later by Prof. C. H. Desch on "The Physicist in Metallurgy," and by Dr. A. E. Oxley on "The Physicist in the Textile Industries."

As no Bill providing for a period of Summer Time was passed by the French Chamber of Deputies before adjourning for the holidays, the French Government has decided not to define such a period this year, but merely to take particular measures in regard to holiday and health resorts.

The seventy-sixth annual meeting of the Palæontographical Society was held on March 31 in the Geological Society's rooms, Burlington House, Mr. E. T. Newton, president, in the chair. The annual report of the council referred to the reduction in the size of the society's annual volume owing to increased costs and smaller membership, but announced the early beginning of new monographs of Malacostracous Crustacea, by Mr. Henry Woods, and of Gault Ammonites, by Dr. L. F. Spath. Contributions had been received towards the cost of plates from the University of Bristol and from Mr. F. W. Harmer. Messrs. A. J. Bull, E. Heron-Allen, H. B. Milner, and A. Wrigley were elected new members of council. Mr. E. T. Newton was re-elected president, and Mr. Robert S. Herries and Dr. A. Smith Woodward were re-elected treasurer and secretary respectively.

A note on cleaner air for London appears in the *Meteorological Magazine* for March. The Public Control Committee of the London County Council is considering how far fog in London is the result of atmospheric pollution due to preventable causes, and how far the atmosphere may be improved by the larger use of electricity for power and other purposes. It is also being considered whether further powers are required to deal with the emission of smoke. Detailed reports have been prepared, and these appear to be under discussion by the Council.

A new type of pocket magnifier is now included in the optical products of Messrs. Cooke, Troughton and Simms, Ltd., Buckingham Works, York. We have had an opportunity of examining one of these. The lens consists of an achromatic doublet giving a magnification of five with a focal length of 2 in., an aperture of 0·85 in., and a field of view of about 2 in. in diameter. The field is flat and free from distortion and colour, and the definition is good over the whole of it. The lens is fitted in a duralumin mount which can be folded when the magnifier is not in use. Magnifiers of this type are now being supplied with powers of 2½, 5, and 10 respectively.

Beginners in bee-keeping will find some useful information in Leaflet 128, recently revised by the Ministry of Agriculture and Fisheries. Bee-keeping is an occupation eminently suitable for small-holders, cottagers, and others with only a limited space available. The insects are, moreover, active pollinators of fruit blossoms, and consequently have other uses besides the production of honey. Having mastered the contents of this leaflet, we advise the beginner to procure the collected leaflets on bee-keeping (seven in number), which can be obtained from the Ministry, at 10 Whitehall Palce, S.W.1, at the low price of 6*d*., post free.

The Gifford Emonds prize, value 100*l*., which is awarded every two years for an essay on a subject dealing with ophthalmology and involving original work, and open to any British subject holding a medical qualification, is now open to competition. The subject chosen is "Iridocyclitis." Preference will be given to original work based on any branch of the subject, rather than to compilations of the writings of previous observers. Full particulars of the prize can be obtained from the Secretary Superintendent, Royal London Ophthalmic Hospital, E.C.1. Essays must be sent in not later than December 31, 1924.

Messrs. H. Sotheran and Co. (43 Piccadilly, W.1) have recently purchased and are offering for sale as a whole the library of books on British ornithology formed by Major W. H. Mullens. It contains about 3000 volumes, and ranges from the "Avium praecipuarum" of William Turner, 1544, to Beebe's recently completed "Monograph on the Pheasants."

The catalogues issued by the firm of Bernard Quaritch, Ltd., 11 Grafton Street, W.1, are always of interest. The latest one (No. 376) contains upwards of 1700 titles (with, in many cases, comments) of books in the following subjects: botany, agriculture, early medicine and surgery, forestry, fruit-culture, gardens and gardening, herbals, and tobacco. As usual, many choice and rare volumes are included.

No. XI. of the "Publications de la Société de Chimie Physique" is a short monograph of 15 pages on isotopes, by M. Maurice de Broglie, which was delivered as a lecture in November 1920. The previous publication was a lecture on Bohr's theory of the constitution of the atom. The monograph is published by Hermann et Cie at the price of 2 francs. Two series of somewhat similar monographs are being issued by the Libraire Scientifique Albert Blanchard. One of these, of which seven parts are announced, consists of groups of two or three lectures on physical subjects. In addition to these a series of foreign scientific monographs is being issued. The third of these, which has recently come to hand, is by Prof. Kossel, and bears the title "Les Forces de Valence et les Spectres de Röntgen." The monograph covers 70 pages, and is issued at a price of 4·50 francs.

The Society of Glass Technology, which has its headquarters at the University of Sheffield, has issued a useful handbook, a "Directory for the British Glass Industry," price 7*s.* 6*d.* to non-members of the Society. The volume is divided into sections providing lists both alphabetical and classified of glass manufacturers and craftsmen, with particulars in most cases of the class of work produced, and lists of firms supplying material and machinery required in glass making and working. The concluding short sections give useful information concerning industrial associations, trades unions, City Companies, educational institutions, and research associations, and publications dealing with glass technology. It is difficult to understand on what principle the selection of a group of publications, mentioned in the last section, which are referred to as "Periodicals in which articles on glass and ceramics occasionally appear," has been made.

Our Astronomical Column.

A Supposed Meteorite at Quetta.—The *Pioneer Mail* for February 23 reports the fall of a supposed meteorite at Quetta on January 25, which, if confirmed, will for the first time establish the power of a meteorite to cause a conflagration. The fragments of the meteorite collected are said to weigh 6 tons, with a volume of 500 cubic feet! Hence the material must be abnormally light for a meteorite. It struck a large stack of closely packed straw 30 feet high, and penetrated it nearly to the ground. The "meteorite" is said to consist of materials like slate-grey igneous rock, volcanic glass, and coke. Possibly the stack was struck by lightning and the fused residue of the straw has been mistaken for a meteorite. The Geological Survey of India will doubtless settle the nature of this phenomenon.

Solar Eclipse Investigations.—At the meetings of the Australasian Association for the Advancement of Science held at Wellington, N.Z., two papers dealing with observations of the total solar eclipse at Wallal were communicated by Prof. A. D. Ross, who was a member of the Crocker Eclipse Expedition of the Lick Observatory. Shadow bands were observed for two minutes before and for one minute after totality. They altered in appearance, but the most persistent type was indistinct dusky bands about 6 inches wide, at 17-inch intervals, moving in a direction 30° S. of E. at 6 or 7 miles per hour. The bands at times came in groups and developed from a general shimmering effect. Their appearance was inconsistent with a diffraction theory, but suggested irregular refraction due to atmospheric temperature inequalities. The wind was from N.N.W. to N.W. at about 4 miles per hour, and there was a temperature drop of about 8° due to the eclipse. By comparison of six photographic plates exposed to a region surrounding the south celestial pole about mid totality and during twilight the same evening, it was found that the eclipse illumination corresponded to twilight with the sun 7½° below the horizon. Wellington Anti-screen plates were used. The humidity was about 45 per cent. at the time of totality and about 50 per cent. at twilight, so that it is unlikely that the estimate of brightness was much affected by variation in the transparency of the atmosphere. Determination of the brightness of the corona was attempted with a specially designed integrating photometer, but the measurements of the plates had not been completed.

Planetary Radiation.—No. 460 of the Scientific Papers of the Bureau of Standards, Washington, contains an account of researches made at Flagstaff by W. W. Coblentz on the thermal radiation from planets and stars. A cell of water 1 cm. thick is used to separate the long heat-waves from planets (due either to inherent heat or to warming of the surface by the sun) from the reflected solar radiation. A vacuum thermocouple made of bismuth wire was used to measure the radiations, the instrument being mounted on the 40-inch reflector. Observations on the moon are stated to confirm Very's results, but are not described in detail.

The observations lead to the conclusion that the planetary (long wavelength) radiations, expressed as percentages of the total radiation received from them, are Jupiter (0), Venus (5), Saturn (15), Mars (30), the moon (80). The high figures for the moon and for Mars indicate that rarity of atmosphere increases the warming of the surface; further, the northern hemisphere of Mars, which was in autumn, and more cloudy than the southern hemisphere, indicated a lower planetary radiation. It is hoped to compare the radiation from the orange and dusky regions of Mars, which might give a clue as to the conjectured interpretation of the latter as regions of vegetation.

The zero figure for Jupiter is concluded to be due to the enormously thick atmosphere, which acts as an opaque screen to the radiations from the (supposed) heated interior. The instrument is restricted to wavelengths 7 to 12 μ. Hence nothing can be stated about radiation between 4 and 7 μ, or from 12 to 15 μ.

The star temperatures are given as 3000° for type M, 5900° for Capella and sun (type G), and 12,000° for type B, in close accord with previous results.

Research Items.

Migrations of the Waxwing.—The waxwing, *Ampelis garrulus*, is not a rare visitor to our shores. Seldom a winter passes but one or more is observed in eastern parts of Britain, and occasionally its numbers indicate a very considerable immigration. The largest ever witnessed in Scotland occurred in the late autumn of 1921, and is discussed by Dr. J. Ritchie in the *Scottish Naturalist*, September 1922–February 1923. The immediate cause of Scotland's share in this immigration is due in the first place to the lack of food-supply in Norway. The summer of 1921 in that country has been notorious for the lack of wild berries upon which the waxwings feed. Large flocks of the birds congregated in the southern part of Norway, but, finding insufficient food, took advantage of easterly winds accompanied by a rapidly rising barometer to reach our shores. The meteorological phenomena associated with the migration are complex, and Dr. Ritchie promises to deal with them in a future paper.

Botanical Survey and Ecology in Yorkshire.—Under this title a most valuable and comprehensive account of the development of our knowledge of the Yorkshire flora is given by Dr. T. W. Woodhead in the *Naturalist* for March 1923. The first flora of Yorkshire was published at Halifax in 1840 by Henry Baines, and since then the three Ridings have been more intensively dealt with in the three well-known floras, Baker's "North Yorkshire," Arnold Lee's "Flora of West Yorkshire," and Fraser Robinson's "Flora of the East Riding of Yorkshire." Many other valuable systematic works dealing with the Yorkshire flora are described by Dr. Woodhead, who then proceeds to narrate the development of botanical survey and the mapping of plant associations, under the inspiration of the brothers Robert and William G. Smith. Around these men an active band of workers gathered, and in December 1904 the Central Committee for the Survey and Study of British Vegetation was formed at a meeting held at the house of Dr. W. G. Smith in Leeds; in 1913 this Committee was replaced by the British Ecological Society with its wider membership. Two vegetation formations that have been extensively studied in Yorkshire are the woodlands and the moorlands, and Dr. Woodhead briefly traces the development of our knowledge of these characteristic vegetation features, their distribution, development and occasional retrogression. There is an interesting discussion of the significance of the vegetation found in the peat of the Southern Pennines, and the bearing that the studies have upon persistence of the flora from pre-glacial times. Dr. Woodhead's work upon the relation of vegetation survey to the many other activities and interests of a district was well illustrated by the extraordinarily interesting series of maps of the Huddersfield area that were on view in Hull during the British Association meeting, in the exhibition room of the Yorkshire Naturalists' Union. It is therefore natural to find that the presidential address to the Yorkshire Naturalists' Union closes with the expression of a hope that such ecological studies may extend to man, and that the local museum may enshrine the results of an intensive local survey of plant and animal, including human communities.

A New Process for making Stereoscopic Maps.—A paper read at a recent meeting of the Paris Academy of Sciences (*Comptes rendus*, January 22) described a new method, due to M. G. Poivilliers, for obtaining stereoscopic maps. The various methods proposed hitherto have been based on the use of two conical perspectives, the production of which involves practical difficulties; in M. Poivilliers's method two cylindrical projections are used, one vertical and the other oblique. Referring to the accompanying illustration (Fig. 1), the projection A is an ordinary contour map; the projection B is obtained from A by shifting the contour lines in the direction east-west by an amount proportional to their altitude above an arbitrarily chosen datum line. The resulting stereoscopic view shows theoretically a slight curvature effect which, however, does not alter the relative relief. In examining with a stereoscope even the above reproductions, the result obtained is very striking. The "falsified" map B was in this case drawn by hand with the aid of a tracing of A, but it is easy to imagine a simple apparatus by means of which this can be done semi-automatically. The contour interval is in this case 20 metres, and corresponds to a horizontal shift of 0·5 mm. It is anticipated that M. Poivilliers's method, on account of its simplicity, will tend to generalise the use of stereoscopic maps, especially for purposes of instruction in topographical surveying. It has also been suggested that the process could be usefully applied to geological maps, by making it possible, for example, to visualise the superposition of successive layers inside the earth.

A—Ordinary contour map. Fig. 1. B—Complementary map, with contour lines displaced.

Atmospheric Humidity in the United States.—Prof. R. de C. Ward, of Harvard University, is the author of a communication on the above subject in the U.S. *Monthly Weather Review* for November 1922. The communication is admirably illustrated with diagrams; two are given for January, at 8 a.m. and 8 p.m., and two for the corresponding hours in July, showing the relative humidity by lines of equal value over the whole of the United States. The element is a real and definite factor in climate, and especially affects our bodily comfort. The values give the ratio between the amount of moisture in the atmosphere and the amount which could be present without condensation. On the Pacific, Atlantic, and Gulf coasts the lines show a distinct tendency to be parallel to the sea-coast. The distribution is chiefly controlled by temperature, direction of prevailing winds, distance, and direction of the chief source of moisture supply, and general topography. Charts given with the communication are taken from the 'Atlas of American Agriculture." A belt of uniformly high relative humidity along the coasts averages about 75-80 per cent., and at times exceeds 90 per cent. on the Pacific coast. Inland, in parts, the minima relative humidity during the hot summers fall to 30 per cent., and even 20 per cent. over the districts of most extreme aridity. Absolute humidity, which shows the actual amount of water vapour in the air expressed in decimals of inches, and known as vapour pressure, is also dealt with; two charts are given showing the equal pressure lines over the United States in the months of January and July. Temperature is essentially the chief control of absolute humidity; in mid-summer the amount of moisture in the atmosphere is generally from two to four times as great as in mid-winter.

Geology and the Ice-cap in Northern Greenland.—The interest of Dr. Lauge Koch's geological mapping in Northern Greenland (Nature, vol. 110, p. 91) is now increased by his preliminary account of Peary Land. His new map (*Am. Journ. Sci.*, vol. 206, p. 190, 1923) shows the continuation of the Caledonian folding through the north of the region, where moraine-matter from the glaciers descending from the south obscures much of a country in any case difficult for research. The ice-cap extended a good deal farther north at the maximum of the Pleistocene ice-age, but did not cover all the coastland. It may be remarked that in this area we have once more evidence of the potency of snow-domes in promoting widely spread glaciation. It seems unnecessary, if unfashionable, to shift the pole to account for every local centre of ice-radiation. The main result of Lauge Koch's recent work is the discovery of a richly fossiliferous Ordovician series far greater in extent and thickness (870 m.) than he could anticipate when he began his arduous explorations in 1917.

Production of Lead in Britain.—In the numbers of *Chemistry and Industry* for March 16 and 23, Prof. H. Louis contributes a most interesting and valuable account of the production of lead in Britain. He begins with a clear account of lead in ancient times. The first definite mention of the production of lead in Britain occurs in Pliny (A.D. 77); a pig of lead has been found in the Mendip Hills bearing the name of the Emperor Claudius (A.D. 49), and in A.D. 64 smelting in Flintshire began. Some pigs of Roman lead are stamped *ex arg.*, *i.e.* desilvered—probably by cupellation. The progress made in the Middle Ages is described in detail by Prof. Louis, whose articles have a wide interest.

Substitution in the Benzene Nucleus.—In the *Chemical News* of March 16, Messrs. R. Fraser and J. E. Humphries discuss the problem of substitution in the benzene nucleus in the light of the Lewis-Langmuir theory of co-valence. They start from three simple postulates related to the octet stability of an atom or group, and discuss in an interesting manner many known results in organic chemistry. In the chaotic mass of unco-ordinated facts which lies heavy on organic chemistry a ferment is evidently moving; in time the material will no doubt be brought into order, and discussions of the type of that mentioned cannot fail to be of service in this direction.

Early History of the Gas Process.—The early history of the manufacture and distribution of towns' gas was briefly outlined by Mr. D. Brownlie in a paper read before the Newcomen Society on March 20. Van Helmont, in 1600, observed that "coal did belch forth a wild spirit or breath." Other early pioneers include Thomas Shirley (1667), Robert Boyle (1691), Stephen Hales (1726), J. Clayton (1739), Bishop Watson (1781), the Earl of Dundonald (1781), and Minckelers (1784). William Murdoch lighted his house at Redruth with coal gas in 1792. At first the gas was burned at the open end of an iron pipe, but the accidental use of an old thimble led to the introduction of a burner in which the gas was lit at a number of jets issuing from a perforated thimble. Messrs. Boulton and Watt's works at Soho, Birmingham, were illuminated by gas in 1802. The plant erected by Murdoch for this purpose differed in little but scale from the horizontal settings and gasometers of to-day. Lebon, in France, worked along much the same lines as Murdoch, and illumined his house with coal gas in 1801. Winsor illumined part of Pall Mall with gas in 1807. Samuel Clegg introduced lime purification in 1806, and invented the first gas-meter in 1815. In the early days gas was distributed through lead or wood pipes. Cast-iron pipes were introduced in 1810, and wrought-iron pipes in 1825. John Grafton, in 1820, introduced the use of fireclay instead of iron for retorts. This permitted the temperature of carbonisation being raised from 1400° F. to 2000° F. Clegg patented retorts for continuous carbonisation in 1815. The first vertical gas retort was patented in 1828 by John Brunton.

Photometry.—In his annual address before the Philosophical Society of Washington, the retiring president, Mr. E. C. Crittenden, presented an interesting survey of problems involved in the measurement of light. The address has appeared in the Journal of the Washington Academy of Sciences (vol. 13, No. 5, March 4, 1923). In the introduction Mr. Crittenden recalls several notable advances in photometry, such as the adoption of the international unit of candle-power by all leading countries except the Germanic nations. In view of the uncertainties attending the use of flame standards, this unit is now usually preserved by the aid of calibrated electric incandescent lamps; the process is analogous to that adopted for the international ohm, derived from a mercury standard but maintained by means of wire resistances. However, there is this important distinction, that we have as yet no adequate, accurate, and reproducible primary standard of light. One of the most hopeful lines of investigation is that pursued at the U.S. Bureau of Standards, where experiments on a black body maintained at a definite temperature have been made; the black body takes the form of a carbon-tube electric furnace matched in colour by comparison with certain standard incandescent lamps. But further information on the accuracy with which temperature can be maintained is needed. The address also directs attention to the fundamental distinction between conceptions of light as radiation, and as a physiological impression—a distinction that becomes specially important when we have to deal with sources yielding light of different colour. The physiological phenomena affecting such comparisons are discussed, and some remarks are made on the results of "equality of brightness" and "flicker photometer" measurements. The visibility curve, throughout the spectrum, of the normal eye has now been ascertained with fair precision. A knowledge of this should enable us to evaluate the luminous power of any variety of radiant energy; and if, in addition, the primary standard based on the black body at specified temperature should prove satisfactory, considerable progress towards the scientific measurement of light will have been made.

Biometry and Genetics.

PROF. RAYMOND PEARL and his students continue to make important contributions to the biology of man and other organisms on a statistical basis. In a recent paper (Pearl and Bacon, Johns Hopkins Hospital Reports, vol. xxi. Fasc. iii.) an analysis is made of the relation of the relative size of heart, liver, spleen, and kidneys to tuberculosis. The data were derived from 1341 autopsies in which there were tubercular lesions. Six indices for the relative weights of the above organs were used as the basis of statistical investigation in relation to age, sex, race, and cause of death. It is shown that the relative weights of liver and heart, and heart and spleen change progressively during life; also that in cases of fatal tuberculosis the absolute weight of the heart is less and of the spleen greater than normal, probably because these changes are brought about by the disease. Curves of age show that when tuberculosis alone is fatal it kills at comparatively early ages. Many other interesting facts are brought out in this statistical study.

In "dry" America, experiments with alcohol have a particular interest. Stockard has shown with guinea-pigs and Pearl with fowls that individuals which throughout life received daily doses of alcohol by inhalation are much longer-lived than their untreated sibs. In a recent note (*Amer. Journ. Hygiene*, vol. ii. No. 4) Prof. Pearl points out that the actuarial data of insurance companies, which are generally supposed to show that the consumption of alcohol in man in any quantity shortens life, are practically worthless. From 1569 family history records carefully collected in the vicinity of Baltimore, he concludes that while heavy or steady drinking lowers the expectation of life, the moderate or occasional consumption of alcohol has no such effect on either sex.

In experimental studies on the duration of life in Drosophila (Pearl and Parker, *Amer. Naturalist*, vols. 55, 56) the authors compare the percentage of survivals at successive ages with the corresponding curve for man. A day in the life of a fruit-fly corresponds roughly with a year in the life of a man. Large numbers of flies of different stocks were bred under carefully standardised conditions. The length of the imaginal life was noted and the results compared with the statistics for man, beginning at the age of fifteen years. Fundamentally similar curves are obtained in the two cases. In Drosophila it is shown that long-winged flies have two or three times as great an expectation of life at any age as short-winged flies, and that other hereditary differences in duration of life also occur. The death-rates generally increase steadily with advancing age. The mortality curve for Drosophila is then compared with that for modern man and for the population of the Roman provinces in Africa about the beginning of the Christian era (from data of MacDonnell, *Biometrika*, 1913). The Drosophila curve generally runs intermediate between these two. The modern curve of human mortality is diverted from the normal by the prolongation of life of many of the less rugged by measures of public health and sanitation.

By selection and inbreeding from Drosophila stocks it was possible to isolate strains showing large differences both in mean duration of life and in the form of the mortality distributions, while in inbred lines the genetic differences remained constant for ten to twenty-five generations. It was shown that occasional etherisation of the flies has no appreciable effect in lessening their duration of life. There is some evidence that in crosses, duration of life may segregate like a Mendelian character. A pedigree indicating something of the same kind in man is presented by Pearl (*Amer. Journ. Hygiene*, vol. ii. No. 3). In the father's family only 10 per cent. survived to the age of fifty years, in the mother's family 75 per cent. reached that age, and in the offspring 87·5 per cent.

Using 100 births/deaths as a "vital index," Pearl and Burger (Proc. Nat. Acad. Sci. vol. 8, No. 4) plot the curve for this index for England and Wales in the years 1838–1920, from statistics in the Annual Reports of the Registrar-General. This ratio shows a slow but extremely steady increase until 1914, with only two slight fluctuations caused by influenza epidemics in 1847 and 1890. The birth-rate in the meantime showed a slow increase until about 1878, then a more rapid decrease until 1914, and a marked recovery since the war. Thus while in the year 1838–39 the number of births for each death was 1·4, in 1920 it was more than 2. The whole curve for the vital index shows a remarkably steady increment in the rate of population growth, with a high degree of regulation of death-rates to variations in the birth-rate. Measured by the criterion of the vital index, it is concluded that the population of England and Wales is "biologically more vigorous" than in 1838. But this merely means that its net rate of increase is greater, and takes no account of the differential character of the birth-rate. In another note in the same issue, Pearl considers the seasonal fluctuations in the vital index of the population, based on the same data, and finds that in each year it has its lowest value in the winter quarter (ending March 31), and its highest value in the summer quarter. In other words, in the winter months the birth incidence is relatively low and the death incidence relatively high, as might be expected.

That density of population influences fecundity was formerly shown for fowls, and similar results have now been obtained for Drosophila (Pearl and Parker, Proc. Nat. Acad. Sci. vol. 8, No. 7). The rate of reproduction of this fly is shown experimentally to vary inversely with the density of population. This is the converse of Farr's law that the death-rate varies directly with density of population. It is suggested that the world-wide increase in density of population may account for the general decline in birth-rates which has taken place in the last forty years. The subject is one which deserves further investigation.

A hexadactylous Norwegian family in which the postaxial digits (little fingers and toes) are double, is described by Aslaug Sverdrup (*Journ. Genetics*, vol. xii. No. 3). The condition is traced through six generations, and two types of polydactylism are recognised. In type A one finger, usually the fifth, is duplicated, while in type B the sixth finger is represented by a small attached appendage. Both these types are already well known. The condition behaves in general as a dominant character, but in one line of the family, showing chiefly the A-type, there is an excess, and in another, showing only the B-type, a deficiency of polydactyls. Moreover, an A-type individual may have either A- or B-type offspring, whereas B-types cannot produce A-types. It is concluded that the B-type is probably determined by a single Mendelian factor with sometimes a failure of dominance, while the A-type is probably due to cumulative factors. The A-type of polydactyly is sometimes accompanied in this family by a form of brachydactyly due to shortening of certain metacarpal bones, but also in some cases to short phalanges. Such papers on the inheritance of human abnormalities are important in their recognition of the necessity for accurate and detailed observations.

In a study of the inheritance of patching in the flower of the sweet pea Prof. Punnett (*Journ. Genetics*, vol. 12, No. 3) introduces facts which cannot be explained on the ordinary Mendelian basis. The sweet pea Duke of Westminster sometimes has on the wings a larger or smaller patch of purplish pink. Such patched plants give normal, red, and patched offspring in varying proportions. Certain branches of "patched" plants are sometimes normal. The seeds from such normal branches show no constant genetic difference from the rest of the plant, nor was any evidence obtained that the normal, patched, and red flowers on a patched plant differed from one another genetically. There is no indication of genetic differentiation in the germplasm of different parts of the plant. Nevertheless, patched plants are not apparently all alike. As in striped Mirabilis, the pair of colour characters may behave either as a segregating Mendelian pair or form a mosaic. There is no sufficient explanation of this mosaic condition at the present time, but it represents a condition differing distinctly from ordinary Mendelian behaviour.

In a second paper on the inheritance of characters in some of the many rice varieties, Mr. F. R. Parnell, with the assistance of Messrs. G. N. R. Ayyanger, K. Ramiah and C. R. S. Ayyangar (Mem. Dept. Agr. India, Botany, vol. xi. No. 8), deals with the colours of glumes and grain, also with dwarfing and with shape of grain. The dwarf variety differs very markedly from the type, but behaves as a simple recessive. A result of economic importance is that the weight of the grain varies with the shape. The hereditary behaviour of a number of colour factors is analysed. Another genetic paper of economic value is a study of certain forms of cotton by Mr. Ram Prasad (Agric. Inst. Pusa. Bull. No. 137). Long fibre is considered to be a dominant character in cotton. Some evidence is obtained that long fibre is correlated with long stigma, plants with short lint having shorter styles. If this is the case it would enable roguing of undesirable plants producing short lint to take place much earlier than would otherwise be possible.

Norway and Iceland: An Interesting Contrast.

NORWAY has many interesting features to a visitor with scientific and technical tastes. The ubiquity of electricity generated from water-power has often been the subject of comment. The peculiar formation of the high tablelands, with lakes at heights of 1000-3000 feet, constantly renewed by water from the snows above, is favourable to hydro-electric supply. The potential value of the water-power of Norway has been assessed at 15,000,000 h.p., of which about one million is at present in use.

The mountainous nature of the country has other interesting consequences. One curious result is that communication between valleys is often less easy in summer than in winter, when roads and passes become covered with deep snow and can be traversed by ski and sleigh. The nature of the country has developed isolated scattered communities with pastoral tastes and special local industries, such as the hand-woven fabrics for which Norway is famous.

The climate has much in common with that of England. Bergen is notorious for its rainfall, and the humid atmosphere is doubtless responsible for the luxuriant growth of trees, springing in masses out of the bare rock lining the fiords in a manner that seems to invite study by experts in forestry. The use of timber in Norway is universal. Buildings are almost invariably of wood, and the humbler cottages are roofed with turf, which seems to thrive in the moist atmosphere. In mountainous Norway grass is scarce. Hence the custom of sending cattle up to the mountain "sæters" in the summer, so that the grass at the level of the fiord can be stored in summer-time. This cut grass is hung up to dry on horizontal lengths of wire. Possibly British farmers could take a hint from this practice, as crops in this country are often spoiled by rain.

Geologically the great tablelands of Norway, with their stretches of perpetual snow at relatively low level, and their vast glaciers (the largest in Europe with the exception of those in Iceland) are of great interest. It is a strange sight to find these great glaciers descending right down to the level of the fiord, as happens, for example, at Fjaerland.

Iceland furnishes some interesting contrasts to Norway. The climate is more stable and less like that of Britain. Whereas in Norway trees are everywhere, in Iceland there are practically none. Hence we find a new material for buildings of the better class—corrugated iron! Grass is also scarce, and Iceland is one of the few countries where rabbits will not thrive. The scenery, though almost destitute of verdure, is not monotonous and has a charm of its own. It consists mainly of alternations of rock, lava, and sand, with, on the lower slopes of mountains, stretches of moss. All vary remarkably in colour. Rocks are black, brown, purple, and occasionally bright red. Sand may have any tint from yellow to black. Amazing changes in colour, difficult to explain and offering an interesting study to the physicist, occur as the sun sets. A curious feature is the astonishing brilliancy of the setting sun, exceeding by far that usual in England. The pools of molten lava also afford a field for study. Their position is indicated by a sulphur-yellow crust, but the upper liquid contents are often bright blue, changing to scarlet at a lower level. Hecla, by the way, although the mountain best known to English readers, is by no means the best example of volcanic action, and is a comparatively inconspicuous mountain.

Ice and snow, usually not far distant in Norway, are universal on the higher mountains of Iceland, and the blanket of ice and snow creeping over the edges of precipices forms an important element in the general scheme of coloration.

In one respect Iceland and Norway seem to be much alike—in the hospitality accorded to the English visitor. In Norway, especially when one leaves the beaten track, one is conscious of an atmosphere very different from that in many hotels in Europe. In Iceland, once he leaves the capital, the traveller finds practically no hotels, but he can rely on the generous hospitality of the districts visited. Ponies are the usual mode of conveyance. It is stated that the import of horses is forbidden, as the Icelandic Government desires to keep the strain of ponies pure.

In Norway the present writer was impressed by the high general level of education. One could converse on equal terms with persons of all degrees, and learn facts of interest about the country. English is a compulsory language in the schools, and is often spoken with considerable facility. Even in Iceland, it appears, English is spoken more frequently than might be expected. Here again there is a high level of education, but owing to the remoteness of the island some strange conceptions of England prevail.

In Iceland, as in Norway, a variant of Danish is spoken. But whereas in Norway the entrance of foreign words is not resented, in Iceland they invariably undergo translation before acceptance. The writer was given to understand that the language is written and spoken in almost exactly the same manner as it was a thousand years ago, and that the ancient sagas can be read with the same ease as the modern newspaper. Probably there is no other country in Europe where this strange perpetuation of ancient forms of speech prevails.

The Survey of India.

THE report by Col. Ryder, the present Surveyor-General of India, referred to below,[1] shows that in the year 1919–20 the Indian Survey Department had fully recovered from the dislocation due to the War.

During this period there were no less than 19 survey parties in the field, of which 12 were topographical. On the normal scale of one inch per mile (much of which was revision) and smaller geographical scales, about 2800 square miles was turned out, while on the larger scales, ranging from 1½ inches to 24 inches and even 64 inches (city and town surveys), the output, detailed partly in miles and partly in acres, was reckoned to be satisfactory. Every class of country was included in the field of work, from the sands of Rajputana to the dense forest-covered hill tracts of Burma, and we read of the time-old difficulties, heavy and continuous rain, malaria, and even of the clearance of villages by man-eating tigers. It is interesting to observe that the sources of the Irawadi (so long a geographical problem) were finally mapped.

Although the costs of the different classes and scales of survey are set out in considerable detail, it is difficult to frame any conclusion as to whether those costs have risen since the War. The normal one-inch scale of original survey apparently varied between 20 Rs. per square mile in Bengal and 70 Rs. in Lower Burma. This does not indicate any great increase on pre-war costs, but in itself scarcely justifies any general estimate.

In the geodesic and scientific branch of the department there is a curtailment of activity. No first-class triangulation was carried out, and both the pendulum and latitude observations were suspended, but the registrations of tidal curves by means of self-registering tide-gauges were continued at Aden and at the principal ports of India. Levelling operations were also continued, and a new geodesic level net of India has been inaugurated on which levelling of high precision on the "fore and back" system will be the method employed. Like the exact determination of the height of the principal peaks of the Himalaya, it might be open to question whether the practical results of extreme precision are worth the expense of determination. The magnetic survey was also carried on during this season. The report closes with the usual returns of the computing- and drawing-offices.

The chief point of interest in the volume is found in Appendix II.—the report on the expedition to Kamet by Major Morshead, who afterwards took such an active part in the Everest expedition. Kamet (25,445 feet high) is the culminating peak of the Zaskar range, and afforded Major Morshead and that distinguished mountaineer, Dr. Kellas, an excellent opportunity for scientific observation on the effect of high altitudes on the human body. Appendix III. is also interesting, recording a note on the topography of the Nun Kun massif in Ladakh by Major Kenneth Mason. He has a good deal to say in criticism of Mrs. Bullock Workman's claim to have established the height and position of certain peaks of that group, in which she disagrees with Indian Survey results. It is always dangerous for the amateur to claim greater accuracy than that maintained by the Trigonometrical Survey of India. Mrs. Bullock Workman, in publishing her account of her extraordinary feats of climbing, pits herself against the G.T.S. and suffers accordingly.

T. H. H.

[1] Records of the Survey of India: Annual report of Parties and Offices for 1919–20, vol. 15.

Polish Celebrations of the 450th Anniversary of the Birth of Copernicus.

NICOLAUS COPERNICUS was born on February 19, 1473, in Toruń (Thorn), a town situated on the Vistula, in the north-west of Poland; the 450th anniversary of the birthday of the great astronomer occurred thus on Monday, February 19, and was celebrated in many parts of Poland with much solemnity. Impressive ceremonies were held in Warsaw, Wilno, Poznań, Lódź, Wloclawek, and Kieke; in the Jagellonian University of Cracow (where for four years, 1491–1495, Copernicus was an undergraduate) the celebrations in commemoration of the anniversary will be held at a later date, probably in May.

In connexion with the Cracow proceedings a work, "Stromata Copernicana," will be published under the auspices of the Polish Academy of Sciences and Letters in Cracow; its author is Prof. L. Birkenmajer, the well-known biographer of Copernicus. We have not the space to enter into an account of Prof. Birkenmajer's investigations, but the following interesting fact may be mentioned: On the October page for the year 1505 of the book "Calendarium Magistri Joannis de Monte Regio," preserved in the Uppsala University Library (sign. "Incunab." 840), Prof. Birkenmajer discovered, in Copernicus's well-known handwriting, the Polish inscription (twice repeated) "Bok pomagay" (Our Lord, help us). Writing on this interesting detail, Prof. Jan Loś, the well-known philologist (and professor of the history of Polish language in the Jagellonian University of Cracow), says: "In the year 1505 every Pole would have written the words given above exactly in the form in which Copernicus has written them" (*Jezyk Polski*, vol. viii., No. 1). Prof. Birkenmajer adds that in 1505, or perhaps in 1506, Copernicus had already in his mind the ideas which eventually took form in the well-known revolutionary "Commentariolus."

The Copernicus commemoration at Toruń extended over the two days—February 18 and 19; delegates from all the universities, high schools, scientific societies, etc., of Poland, and other guests were cordially received by the municipality and citizens of Toruń. The proceedings included the inauguration of the first general meeting of the Polish Astronomical Society. This meeting resolved unanimously to ask the Polish nation to establish a National Astronomical Institute in Poland; an attempt with this object in view was made by Prof. Banachiewicz, of the Jagellonian University of Cracow, and exists in the form of an astronomical station in the Carpathian Mountains. A memorial tablet on the house where Copernicus was born was also unveiled.

Pathology of Market Produce.

DURING recent years great efforts have been made by the biologist to gain such a knowledge of the diseases of cultivated crops as will permit methods of control to be placed at the disposal of the grower.

A reference to the pages of the *Annals of Applied Biology*, the official organ of the Association of Economic Biologists, together with the number of other papers published each year dealing with the life history of disease-producing organisms infecting plants, will show that considerable progress has been made in this still comparatively new field. But some brief papers published in *Phytopathology*, the official organ of the American Phytopathological Society, will show that in the United States a new field of scientific investigation has been opened between the crop and the consumer. Much of the produce, especially of market garden and greenhouse, is extremely perishable, and the cost of fruit or vegetables to the consumer is largely contributed to by the heavy loss that occurs during transit and marketing.

In 1917 in the States a Food Products Inspection Service of the Bureau of Markets was established and was soon working in close collaboration with the trained investigators of the Bureau of Plant Industry.

As is pointed out by G. K. K. Link and M. W. Gardner in a brief review of the first year's work that resulted from the joint attack upon the pathology of market crops (*Phytopathology*, 9, pp. 497–520), the first result was a revelation of the enormous economic importance of the problem, to which the long distances of transit in the United States naturally contributed. In water-melons alone, from four States during 1918, the market inspection services record a loss of 1¼ million dollars, while hundreds of car loads of grapes from California were almost a total loss, due to decay induced by Botrytis, Penicillium, and Aspergillus. Furthermore it was found that these losses, stoically borne by the trade as "part of the game" and passed on to the consumer, very largely arose from preventable causes, with the result that pathologists are being pressed to extend their survey from the growing crop to the study of the crop during harvesting, storing, shipping, and marketing.

Another line of biological inquiry has also been indicated: the task of salvage when prevention of loss is no longer possible. Most of these diseases are fermentation processes, and a controlled fermentation may yield a by-product of value. At the outset the market pathologist has found himself forced to recognise almost a new type of disease organism. Under field conditions this type has limited importance, but under market conditions the plant tissues are less resistant and these organisms show much greater virulence while attacking a wide range of plant species; among such organisms are found the bacterial soft rots and Botrytis.

The American pathologist has already reached the stage at which his first survey enables him to indicate to grower and salesman the most harmful types of disease, the characters by which they may be recognised by the non-expert eye, the conditions leading to the spread of these diseases and the most practicable methods for their control during transport and storage. It may be argued that in Great Britain, the small distance involved in transit renders the question of less importance. But short distances do not always mean rapid transit, and in any case, the most casual inspection of a fruit and vegetable market would show that American experience in this question may be of real value.

Of general application also are such results of the preliminary American work as their experience with strawberries, where N. E. Stevens finds (*Phytopathology*, 9, pp. 171–177) that strawberries picked early in the day, even if wet, keep better than those berries picked after the sun has been on them for some hours. Pomologists also will be quick to admit that we have still to learn the reasons for the different keeping qualities of the same variety of apple if gathered under different conditions. Under the stimulus of war conditions very great progress was made in Great Britain in the investigation of food storage conditions, and as a consequence some attention has been paid in recent scientific communications to the organism found causing damage among stored produce. American experience, however, would seem to raise the more general question whether the phytopathological experience of the investigator should not be reorientated so as to embrace the whole history of the vegetable, from field to table.

The Eruption of Sakura-jima in 1914.

PROF. OMORI has recently (*Bull. Imp. Earthq. Inves. Com.*, vol. 8, pp. 467-525) published his sixth, and apparently last, memoir on the eruption of Sakura-jima of January 12, 1914, and following days—the greatest of all known eruptions in Japan, if greatness be measured by the amount of lava outflow and ash precipitation. The six memoirs fill a volume of 525 pages and are illustrated by 107 plates. They constitute, according to the author, "a modest geometrical and seismological report on the great Sakura-jima eruption of 1914, and the course of the after-events followed for the next 8 years." Prof. Omori's readers will, I imagine, take a somewhat different view. They are more likely to regard the volume as the finest monograph, from a physical point of view, that has ever yet been written on a volcanic eruption.

Summaries of previous memoirs have from time to time appeared in these columns.[1] The first (September 1914) contains a general account of the eruption and its accompanying phenomena. The second memoir (April 1916) deals with the sound and ash-precipitation areas of the eruption, the accompanying changes of level and the earlier outbursts of the volcano. The third (December 1916) summarises the subsequent course of activity. After a pause of more than three years, the fourth memoir (March 1920) appeared containing the results of the levelling surveys and the soundings in Kagoshima Bay made after the eruption. The fifth part (March 1920) is devoted to the seismographical observations of the fore-shocks and after-shocks, while the sixth (November 1922) deals chiefly with the destructive earthquake of January 12, 1914.

The interest of this earthquake lies in its occurrence during the eruption about 8½ hours after it began. It was clearly a tectonic, and not a volcanic, earthquake. Instead of being a sharp brief shock of small disturbed area, the movement at Kagoshima was of considerable strength and duration; it was felt for about 220 miles to the N.E. and S.S.W., and was strongly registered by European seismographs.[2] The epicentre was situated in the Kagoshima channel, about 4 km. south-east of the observatory in that

[1] Vol. 94, p. 289; vol. 98, pp. 57-58; vol. 100, p. 35; vol. 106, pp. 165-166.

[2] NATURE, vol. 92, 1914, p. 717.

city. Judging from the duration (1·9 seconds) of the preliminary tremor, Prof. Omori infers that the focus was distant 14 km. from the observatory and therefore at a depth of 13 km. Numerous stone-lanterns and tombstones were overthrown in Kagoshima, the average direction of their fall being N. 68° W., which agrees roughly with the direction of the first movement registered in the same place. The trigonometrical re-survey of the district revealed horizontal movements since the eruption began of 2·62 to 4·52 metres to the north-east and north in the north and north-west parts of the island, while new soundings made in the north part of Kagoshima Bay showed that the floor of the bay had sunk from one-half to four fathoms, except in two spots in which a rise of from one to three fathoms had occurred. An hour or a little more after the earthquake, small sea-waves or *tsunami* swept over the shore at Kagoshima. At about the same time or later, the cable from Kagoshima to Sakura-jima, which crosses one of the elevated spots, was fractured on the flat bottom of the channel about one-third of its width from the coast of the island. Prof. Omori points out that it was not a single clear fracture, such as might have been formed if the application of the tension had been instantaneous, but that numerous breakages occurred over a length of 420 feet, the average distance between successive breaks being 1·7 feet. He infers that the horizontal and vertical movements of the sea-bed took place gradually.

The occurrence of a great tectonic earthquake in a volcanic district and during the progress of an eruption is somewhat rare. Prof. Omori gives some other examples from Japan in this memoir. Their connexion with the corresponding eruptions can scarcely be doubted. It seems equally clear that they do not owe their origin to the volcanic outburst itself, but that eruption and earthquake are both effects of the same deeply-seated cause.

C. Davison.

Fishery Research in Lancashire.

THE report on the scientific fishery investigations carried out under the auspices of the Lancashire and Western Sea Fisheries District Committee during the year 1921, which is edited by Prof. James Johnstone, the honorary director of the scientific work, is characterised by the extremely cautious way in which it has been drawn up. While the absence of very definite conclusions must to some extent be a matter for regret, it has to be admitted that the amount of evidence collected, though very extensive when considered in the aggregate, is still insufficient to make any other course possible for a highly-trained and critical mind. Like so much of the valuable fishery work which has been accomplished during the last twenty or thirty years, these investigations have tended to show how exceedingly complex the problems may become, and how difficult it is to get together data sufficiently varied in character and in sufficient quantities to provide material for their solution. The investigations do, however, afford clear indications of the lines upon which future research should proceed and make it certain that many of the questions discussed may be answered in the future, if the necessary facilities can be provided on an adequate scale.

The two most important articles in the report deal with the plaice and the herring. The plaice investigations were commenced in 1908 and were specially extended in 1919–21. They are now summarised for the whole period in a series of tables which include all the data. These tables will have a permanent value as a record of the condition of the plaice population, and will be invaluable for comparison with the results obtained in future years. The discussion of the data is limited to broad general features, and is directed throughout to show the bearing of the work on the actual practical problems with which the Sea Fisheries Committee is called upon to deal.

The herring work is of a more technical statistical character, and it is difficult to avoid a feeling of regret that so much work in mathematical analysis has been carried out upon samples containing for the most part only 50 fish. The work, it is true, is preliminary, and it will probably be found more profitable in the future to examine fewer samples and fewer characters but with very much larger numbers of fish.

Mention must be made of Mr. R. J. Daniel's work on the chemical composition of mussels, especially on the substance which has been called "glycogen" in these shell-fish. It is most important that these biochemical studies should be continued, for they promise results of much interest.

The report of the Marine Biological Station at Port Erin for 1922 has also been published recently. The most important paper in this report is by the late Prof. Benjamin Moore, in co-operation with Messrs. E. Whitley and T. A. Webster, on the subject of photo-synthesis in marine algæ. The authors show that green, brown, and red algæ are arranged on the shore so that each kind is in that intensity of illumination which is the optimum for the colour scheme of chromophylls it possesses. In strong illumination, green algæ synthesise far more rapidly than red, but in weak illumination the red algæ synthesise more rapidly than green. The brown algæ are intermediate in their action.

The two reports reflect credit both on those responsible for the organisation of the investigations and on those who have carried them out.

University and Educational Intelligence.

Aberdeen.—By the bequest of the late Miss Anne Hamilton Cruickshank in 1911, a sum of money was set aside for the foundation of a chair in astronomy. The special trustees have now reported to the University Court that the accumulated sum available exceeds 15,000*l.*, and have recommended the foundation of a chair, or lectureship, in astronomy, including navigation and meteorology. The recommendation is under consideration by a committee of the Court. Miss Cruickshank was the daughter of John Cruickshank, professor of mathematics in Marischal College and University from 1817 to the union of the Universities in 1860. Miss Cruickshank also founded the Botanic Gardens and the Cruickshank Law prize, while the Science Library of the University is associated with her name.

Notice is given that the Blackwell Prize Essay, value 30*l.*, and open to all, will be awarded in 1924 for the best essay on "The History of the Fishing Industry of the Port of Aberdeen since 1800," provided any essay sent in is of sufficient merit. Each essay (which must bear a motto and be accompanied by a sealed envelope bearing the same motto and enclosing the name and address of the sender) must be sent to reach the Secretary of the University not later than January 1, 1924.

Cambridge.—A Bill has been presented to the House of Lords appointing Statutory Commissioners for the Universities of Oxford and Cambridge to make statutes and regulations in general accordance with the recommendations contained in the recent Report of the Royal Commission. The Cambridge Commissioners named in the Bill are Viscount Ullswater (chairman), Bishop Ryle, Sir Thomas Heath, Sir Richard Glazebrook, Sir Henry Wilson, Sir Hugh Anderson, Dr. Peter Giles, Mr. William Rendell, and Dr. Hugh Dalton. It is perhaps significant of the difference between the two Universities that the only Fellow of the Royal Society among the Oxford Commissioners is Sir Archibald Garrod, Regius professor of medicine. A few only of the provisions in the Bill can be selected for mention here. In making statutes the Commissioners are to have regard to the main design of the founder of any institution or emolument affected by the statute. In the case of a statute affecting a college they are to have regard to the maintenance of the college in the interests of education, religion, learning, or research. In particular, in prescribing the scale or basis of assessment of contributions made by the colleges to University purposes, regard is to be had in the first place to the needs of the several colleges in themselves for educational and other collegiate purposes. It is not desired in reforming Oxford and Cambridge to reform away the peculiar characteristics which have built up their present strong position in the world of education, religion, learning, and research.

Dr. G. S. Graham Smith, Pembroke College, has been appointed reader in preventive medicine; Dr. J. T. MacCurdy, Corpus Christi College (also of Toronto and Johns Hopkins Universities), has been appointed University lecturer in psychopathology; J. Mills, research student, Gonville and Caius College, has been elected to the Nita King research scholarship in the etiology, pathology, and prevention of fevers.

London.—The latest date for the receipt of applications for grants from the Dixon Fund for the assistance of scientific investigations is May 14 next. Applications, accompanied by the names and addresses of two references, must be sent to the Academic Registrar, University of London, South Kensington, S.W.7.

Dr. Ethel N. Miles Thomas, fellow of University College, London, has been appointed lecturer in botany and zoology at University College, Leicester.

The *Times* announces that Sir Walter Buchanan, a pioneer of the frozen-meat export industry, has given 10,000*l*. for the establishment of a chair of agriculture at Victoria College, Wellington (N.Z.).

The University of Budapest announces that summer courses will be held this year from August 1 to September 15 under its auspices. Lectures will be given by members of the faculties of theology, law, medicine, arts, and economics. Full prospectuses are in preparation.

The Government of Western Australia has allocated a special grant this year for the commencement of the permanent buildings of the University of Western Australia, Perth. As recommended by the professorial board, the science departments will be the first to be removed to new premises, and the present grant for the period ending June 30, 1923, is for the provision of a joint building for the biology and geology departments. The next buildings to be erected will be those for chemistry and for physics. The new site for the University is at Crawley, and covers an area of about 160 acres. The science buildings will be placed on high ground adjoining the national reserve of King's Park, and their southern frontages will command a splendid view of the broad sheet of Melville Water on the Swan River.

We notice that numerous appeals have been issued by professors in Germany for money for institutions for higher education and research, such as the Emperor William Institute for Physics, the English Seminary in Berlin University—by Prof. Alois Brandt, who advocates the compulsory teaching of English in all the higher public schools of Germany—the Cancer Research Institute, the Seminary for Christian Archæology, the Egyptian Seminary, and the High School of Jewish Studies. It is stated that a good deal of political recrimination has found its way into the appeals. Whatever may be thought of the policies of the German Government since the War in other respects, it cannot fairly be charged with failure to appreciate the vital importance of education. We have excellent authority for believing that throughout its financial difficulties Germany has had no disposition to economise in its educational expenditure. The universities, as was pointed out in these columns some months ago, were never depleted of students during the War to anything like the same extent as ours, while since the War they have been filled to overflowing; but the appeals would seem to indicate that the Government has been less generous to institutions for higher education and research than to the elementary and secondary schools and the new "People's High Schools." The depreciation of the mark has of course led to difficulties in the way of obtaining English books and periodicals, and these have been to some extent met by a system of exchange with British universities established last year by the Universities Bureau.

The twenty-first annual meeting of the Carnegie Trust for the Universities of Scotland was held on February 14, Lord Sands presiding. The original endowment fund of 2,000,000*l*. has been increased by 547,000*l*., in addition to which there are reserve funds amounting to nearly 183,000*l*. Expenditure for the year ended September 30, 1922, amounted to 125,292*l*., including: assistance in payment of class-fees, 61,217*l*.; grants to universities and colleges for buildings, lectureships, libraries, etc., 44,925*l*.; encouragement of post-graduate study and research, 17,063*l*.; annual grant to women students' union, 250*l*.; management expenses, 5193*l*. Post-graduate study and research were encouraged by fellowships, scholarships, and prizes (6958*l*.), grants towards salaries of part-time research assistants (3600*l*.), grants to the Laboratory of the R.C.P., Edinburgh (2740*l*.), to St. Andrews Institute for Clinical Research (1000*l*.), and other grants (2765*l*.). Arrangements were made with the Department of Scientific and Industrial Research for the simultaneous consideration of applications. During the year sums amounting to 1387*l*. were voluntarily repaid by or on behalf of 39 beneficiaries, making a total of 12,583*l*. repaid since 1901. The repayments by women exceeded those by men for the first time both in number and total amount. In the annual report of the Carnegie Corporation of New York, issued a few days earlier than the Scottish report, stress is laid on the dangers and difficulties incidental to the administration of all such charitable foundations and the necessity for the exercise of careful discrimination and constant watchfulness for the harmful as well as the beneficial results of giving. Among the former it mentions the overcrowding of the colleges with students, many of whom would find their greatest happiness in other vocations than those to be sought through college training.

Societies and Academies.

London.

Zoological Society, March 20.—Prof. E. W. MacBride, vice-president, in the chair.—S. Ch. **Sarkar**: A comparative study of the buccal glands and teeth of opisthoglyph snakes, and a discussion on the evolution of the order from Aglypha.—Oldfield **Thomas** and M. A. C. **Hinton**: On the mammals obtained in Darfur by the Lynes-Lowe expedition.—R. I. **Pocock**: (1) On the external characters of Elaphus, Hydropotes, Pudu, and other Cervidæ. (2) The classification of the Sciuridæ.

The Optical Society, March 22.—Instr.-Commander T. Y. Baker in the chair.—Dr. L. C. **Martin**: Surveying and navigational instruments from a historical standpoint. Before A.D. 150 accurate knowledge of the Mediterranean basin was obtained by Ptolemy. One of the best known of the early instruments was the astrolabe, and this instrument was developed considerably by the Arabs and others. Specialised forms were used for navigation. In the seventeenth century a simplified form of the astrolabe, capable of being suspended or mounted horizontally on a stand, was employed as a theodolite. This was subsequent to the description of Digges's *theodolitus*, in which independent horizontal and vertical axes were employed. The use of the telescopic sight was not applied to surveying instruments till the beginning of the eighteenth century. The history of the level, from the "open sight and gravity controlled" forms to the telescopic levels of Picard and the bubbles of Thévenot, was also discussed. Improvements by various artists in the methods of graduation of circles and the development of dividing engines from Hindley to Ramsden and Troughton were matters of the greatest moment in the development of modern instruments. Later developments were shown in the instruments by Troughton and by Cary, which brought the level of construction (from the purely scientific point of view) almost up to that of our own time.

Cambridge.

Philosophical Society, March 5.—Mr. C. T. Heycock, president, in the chair.—Sir Ernest **Rutherford**: The capture and loss of electrons by α-particles. In a recent paper (Proc. Roy. Soc. A, 102, p. 497, 1922) G. H. Henderson showed that swift α-particles can capture electrons and are thus converted into singly charged and neutral helium atoms. The magnetic deflexion of a pencil of α-rays in a high vacuum showed by the photographic method after passing through mica the presence of two bands—one, the main band, due to He + +, and the other, the midway band, due to He + particles. The relative number of the latter increased rapidly with reduction of velocity of the α-rays. These conclusions have been confirmed by the scintillation method. By deflecting the midway band by a combined electric and magnetic field, it has been proved that it is due to He + particles. For any velocity there is a temporary equilibrium between the number of He + + and He + particles, such that the number of captures is equal to the number of losses. The ratio of the numbers of singly and doubly charged particles between the velocities $7 \cdot 7 \times 10^8$ and 18×10^8 cm. per second, varies approximately as the inverse fifth power of the velocity. The disappearance of the midway band when gas at low pressure is introduced in the path of the rays gives a method of determining the mean free path of the He + particles in air and other gases before conversion into He + +. The mean free path varies roughly as the velocity of the α-rays, and is 4 to 5 times longer in hydrogen and helium than in air. The mean free path for capture varies roughly as the inverse sixth power of the velocity. The mean free path in air for a velocity $1 \cdot 5 \times 10^9$ cm. per sec. is about 0·56 mm. at N.T.P. for capture and 0·008 mm. for loss. The average α-particle captures and loses an electron many hundred times before it is absorbed.—P. **Kapitza**: Some observations on α-particle tracks in a magnetic field.—H. **Lamb**: The magnetic field of a helix.—W. **Burnside**: (1) The theory of errors of observation; (2) The solution of a certain partial difference equation.—P. M. S. **Blackett**: A note on the natural curvature of α-ray tracks. An apparent relation exists between the plane and direction of the curvature of the parts of a forked track and the plane and type of the fork itself. The natural curvature possibly involves the effect on the ionisation of the probable assymmetric structure of singly charged α-particles.

Sheffield.

Society of Glass Technology (Birmingham meeting), March 21.—Prof. W. E. S. Turner in the chair.—H. S. **Blackmore**, Violet **Dimbleby**, and W. E. S. **Turner**: A rapid method of testing the durability of glassware. When a very dilute solution of 1 part in 1000 of the alkaloid, narcotine hydrochloride, is heated to boiling-point inside a glass vessel, the alkaloid is thrown out of solution, and can be seen as a fine precipitate if the glass is of poor quality. Good glasses should show no sign of deposit when heated at the boiling-point for an hour.—D. **Turner** and W. E. S. **Turner**: The corrosion of fireclay refractory material by glass and glass-making materials.—Edith M. **Firth**, F. W. **Hodkin**, and W. E. S. **Turner**: The effect of saltcake in corroding fireclay materials. Both papers were presented by Prof. Turner. Experimental evidence was detailed, showing that in glass-melting the corrosion of the pots or the tank blocks is most severe during the early stages of the melting of the batch; sodium nitrate, potassium nitrate, and borax are particularly corrosive. As the proportion of saltcake used in the batch increased, so did the extensiveness of the corrosion. Resistance to corrosion can be improved by firing the pots and blocks at 1400° C. before the charge of batch was inserted

Paris.

Academy of Sciences, March 19.—M. Albin Haller in the chair.—The president announced the death of M. Van der Waals, foreign associate.—Emile **Borel**: The approximation of rational or incommensurable numbers belonging to given enumerable ensembles.—L. **Lecornu**: The time of revolution of the planets. A discussion of a question raised in a recent note by M. Jean Chazy.—Charles **Moureu** and Charles **Dufraisse**: Auto-oxidation and anti-oxygenic action. The catalytic properties of iodine and its compounds. The case of acrolein. According to the theory of the mechanism of anti-oxygenising action developed by the authors, iodine and its compounds should exert catalytic properties in phenomena of auto-oxidation, and should, under certain conditions, possess the anti-oxygenising property. Iodides of various metals and organic bases (33 in all) were shown to inhibit the oxidation of acrolein at a concentration of 1 in 1000.—L. **Maquenne**: The hydrolysis of maltose by malt extract.—G. **Gouy**: The improvement of the microscope by the use of X-rays.—C. **Guichard**: Triply indeterminate systems of spheres, circles, and double points.—Jules **Andrade**: An arrangement of four regulating springs producing a constant friction and a quadratic friction.—J. B. **Senderens**: The catalytic dehydration of alcohols by dilute sulphuric acid. Both the ether and substituted ethylene can be prepared by the action of sulphuric acid on the corresponding alcohol, and the ratio of ether (alkyl oxide) to ethylene can be varied by the addition of water to the acid.—Ph. **Glangeaud**: A trial boring for petroleum at Crouelle, near Clermont-Ferrand (Puy-de-Dôme). The boring was taken down to 856 metres, and full details of the strata met with are given. At 596 metres there was a strong evolution of inflammable gas and about a ton of a heavy oil was collected (density 0·963, sulphur 9·3 per cent.). More oil, in smaller quantities, was obtained at greater depths. The tube was broken by an accident at 787 metres.—M. Emanuele **Paterno** was elected foreign associate, in succession to the late Prince of Monaco.—Georges **Bouligand**: Some points in functional analysis.—W. **Margoulis**: The general theory of the representation of equations by means of mobile elements.—J. **Haag**: The problem of n bodies in relativity.—Henry **Hubert**: A method, considered as new, for the stereoscopic representation of topographical surfaces.—R. **Dufour**: High frequency induction furnaces.—A. **Leduc**: A new improvement of the equation of state of gases.—Léon and Eugène **Bloch**: Spark spectra of higher order. A study of the spectrum of mercury obtained by the oscillating discharge in a silica tube without electrodes. The appearance and number of lines change as the voltage increases.—C. E. **Guye**: The kinetic interpretation of the rule of van't Hoff.—Réne **Audubert**: The action of gelatin upon concentration cells. A study of the effect of the progressive addition of gelatin on the E.M.F. of the concentration cells $AgI—AgNO_3$; $AgCl—AgNO_3$; $Ag_2S—AgNO_3$. The results appear to show that the Ag ion is adsorbed by the gelatin.—L. **Bert**: A new synthesis of cumene and p-cymene. Isopropyl sulphate reacts with C_6H_5MgBr giving cumene: the magnesium derivative of p-bromotoluene with isopropyl sulphate reacts similarly, giving p-cymene.—Emile **André**: The acid-alcohols contained in the oil from grape stones.—Henry **Joly**: Some peculiarities of the Bajocian in the neighbourhood of Montmédy (Meuse).—Ch. **Maurain**: Magnetic measurements in Brittany. The results of observations made at forty-one stations in August and September 1922, and the magnetic elements (declination, inclination, and horizontal component) reduced to January 1, 1922.—Filippo **Eredia**: The temperature of the air in the province of Tripoli.—L. **Blaringhem**: New facts relating to the hybrids of wheat and Ægilops.—H. **Colin** and Mlle. Y. **Trouard-Riolle**: Dissociation of the hybrid: smooth-bearded black barley and Albert barley.—Lucien **Daniel**: Regeneration of the potato by grafting. An account of attempts to increase the resistance to disease of the potato by grafting on tomato. The experiments have given promising results.—A. **Polack**: The accommodative compensation of the chromatism of the eye. Insufficiency of d'Alembert's theory.—L. **Garrelon** and D. **Santenoise**: Relations between the resistance of the organism to poisons and the rapid modification of the oculo-cardiac reflex. Contribution to anti-anaphylaxy.—Marc **Romieu**: Contribution to the comparative histology of striated muscle.—Mme. J. Samuel **Lattès**: The physical conditions which accompany the phenomenon of necrosis produced by radium radiation.

Official Publications Received.

Report of the Rugby School Natural History Society for the Year 1922. Pp. 52. (Rugby.)

The National University of Ireland. Calendar for the Year 1922. Pp. viii+323+334+86. (Dublin.)

Annals of the Transvaal Museum. Vol. 9, Part 3: The Sphegidæ of South Africa. By Dr. George Arnold. Part 2. Pp. 143-190. Vol. 9, Part 4: The Sphegidæ of South Africa. By Dr. George Arnold. Part 3. Pp. 191-253. (Cambridge: Printed at the University Press.)

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1922. With Report and Notes of the Director, Rev. A. L. Cortie. Pp. xv+43. (Blackburn.)

Annuaire de l'Observatoire Royal de Belgique, 1924. Pp. vi+550. (Bruxelles: M. Hayez.)

Diary of Societies.

MONDAY, April 16.

Royal Geographical Society (at Lowther Lodge, Kensington Gore), at 5.—W. Irwin: The Salts of the Dead Sea and River Jordan.

Royal College of Surgeons of England, at 5.—Prof. Shattock: Demonstration of Specimens Illustrating Repairs of Fractures.

British Psychological Society (Industrial Section) (at University College), at 6.—Dr. G. H. Miles: Rest Pauses.

Royal Society of Arts, at 8.—E. Kilburn Scott: The Fixation of Nitrogen (2). (Cantor Lecture.)

Chemical Industry Club (at 2 Whitehall Court), at 8.

TUESDAY, April 17.

Royal Institution of Great Britain, at 3.—Sir Arthur Keith: The Machinery of Human Evolution (2). How Old Structures are Lost.

Royal Society of Medicine, at 5.—General Meeting.

Royal Statistical Society, at 5.15.—Dr. E. C. Snow: Trade Forecasting and Prices.

Royal Society of Medicine (Orthopædics Section), at 5.30.

Institution of Civil Engineers, at 6.—Special General Meeting.

Institute of Marine Engineers, Inc., at 6.30.—R. Clark: The Operation of Water-tube Boilers for Cargo-Passenger Ships.

Royal Photographic Society of Great Britain, at 7.—J. C. Dollman: Difficulties in Painting and Photography.

Royal Anthropological Institute, at 8.15.—Miss Tyra de Kleen: The Ceremonial Dances and Magic Rites of the Island of Bali, Dutch East India.

WEDNESDAY, April 18.

Royal Meteorological Society, at 5.—W. H. Dines and L. H. G. Dines: An Examination of British Upper Air Data in the Light of the Norwegian Theory of the Structure of the Cyclone.—Tatuo Kobayasi: The Mechanism of Cyclones and Anti-cyclones.—Capt. E. C. Shankland: Notes on the Fluctuations of Mean-sea-level in Relation to Change of Atmospheric Pressure, from Observations at Liverpool, August and September 1920.

Geological Society of London, at 5.30.—J. F. N. Green: The Structure of the Bowmore-Portaskaig District of Islay.

Royal Microscopical Society, at 8.—D. W. Cutler: The Protozoa of the Soil.—Prof. A. C. Seward: The Use of the Microscope in Palæobotanical Research.

THURSDAY, April 19.

Royal Institution of Great Britain, at 3.—Prof. A. O. Rankine: The Transmission of Speech by Light (2).

Linnean Society of London, at 5.—E. Heron-Allen and A. Earland: The Foraminifera of Lord Howe Island, South Pacific.—The General Secretary: The History of Botanic Illustration in Colour during Four Centuries.

Institution of Mining and Metallurgy (at Geological Society of London), at 5.30.

Society for Constructive Birth Control and Racial Progress (at Essex Hall, Strand), at 8.—C. E. Pell: Is the Fall in the Birth-rate a Natural Law?

Chemical Society, at 8.—R. Ibbotson and J. Kenner: The Influence of Nitro-groups on the Reactivity of Substituents in the Benzene Nucleus. Part VII. Reactions of 2:5- and 4:5-dinitro-m-xylene.—S. F. Birch, G. A. R. Kon, and W. S. G. P. Norris: The Chemistry of the Three Carbon System. Part I. The Influence of the *Cyclo*hexane Ring on the $\alpha\beta$-$\beta\gamma$ Change.—S. Medsforth: The Promotion of Catalytic Reactions. Part I.

FRIDAY, April 20.

Royal Society of Arts (Dominions and Colonies and Indian Sections), at 4.30.—Sir Richard A. S. Redmayne: The Base Metal Resources of the British Empire.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: The Shape and Relationships of the Stomach.

Institution of Mechanical Engineers, at 6.

Junior Institution of Engineers, at 7.30.—H. H. Munro: The Business of Engineering.

Institution of Engineering Inspection (at Royal Society of Arts), at 7.30.—C. H. Richardson: The Inspection of Ball Bearings.

Royal Photographic Society of Great Britain, at 8.—J. Sewell: The Commercial Aspects of Pictorial Photography.

Royal Society of Medicine (Anæsthetics Section) (Annual General Meeting and an Ordinary Meeting), at 8.30.—Dr. J. H. Chaldecott and others: Discussion on Coroners' Inquests: the Classification of Anæsthetic Deaths as violent or unnatural.

Royal Society of Medicine (Electro-Therapeutics Section), at 8.30.—Dr. R. W. A. Salmond: A case illustrating the value of Pneumoperi-cardium.

Royal Institution of Great Britain, at 9.—Dr. W. J. S. Lockyer: The Growth of the Telescope.

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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Science and Government Administration.

SENSE, experience, humility, and imagination may teach one the need of advice: but some understanding of the subject is required to know whom to ask for advice and how to ask him; and still more to select advice, apply it, and act on it. In scientific matters this receptiveness of the recipient is an essential condition, otherwise the adviser is merely pouring water upon a flat plate; it bounces off, yet the plate shines and glories in its wetness.

In view of the supremely scientific character of modern war, can we say that the Army Council, Board of Admiralty, and Air Force Council possess the *sine qua non* for asking, selecting, applying, and acting on scientific advice in relation to the myriad problems of their occupation? These administrative bodies are called upon to foresee the wants of war and to make purchases and initiate researches for their fulfilment. They should, therefore, not only know what is wanted, but also understand what can be obtained. In the restricted sense of this use of the word "want" Julius Cæsar did not *want* electric light. He would have had to be even more remarkable than he was to want it, and then he could not have described the want effectively to any listener.

It is quite common for the lay public to be too unacquainted with what it can get to form a clear idea of its requirements—the man who tries to install central heating, or drains, without architect or builder will understand what is here meant. Luckily most people have sufficient knowledge of the subject and feeling of humility to determine them to go to the architect—that is because central heating and drains are everyday things. The lay public did not want railways—it did not know how to want them; it did not want automobiles until some years of education had been applied, and, coming nearer to our subject, the Army and Navy did not want aeroplanes until long after they were shown them. We are not making an accusation, but merely giving examples to show that the human faculty of wanting is a function of knowing what can be evolved, that is, education; and of imagining to what uses that provision can be extended, that is, vision.

There is the reciprocal of this also in "*not*-wanting." Ask any young officer at random if he wants the Finance Member of the Army Council; facetiously, but not without disclosing a true feeling, he will reply that "he has no use for him." With fairly precise analogy, if it were to be suggested to any member of the three councils named that a man of distinguished scientific attainments is wanted on these councils, he would with equal conviction, equal error, and possibly with equal facetiousness say, they "have no use for him" . . . "they have their advisers."

Suppose that there rises to the top at rare intervals a scientific admiral, "M.G.O.," or "Member for Supply and Research," it still remains the fact that in the absence of provision for securing by the law of the land that there *shall* be a man of wide scientific attainments on those councils, we cannot depend that, when a problem arises in council, its possible relation to science will be automatically and early considered. In many cases science will not be thought to touch the matter at all—and no attempt be made to get such advice. Unless there be some one, with full rights of membership, to probe into what can "per impossibile" be got from science, it is no comfort to know that there exist outside the Council advisers of great skill—since they would not be consulted—nay, they could not be consulted owing to the difficulty for the inexpert to pose the question even if he suspects the want.

A strong case can be made out for a scientific member of council—present at the fountain-head of war policy—at the place where the large problems arise, just as there is, at present, a finance member of council. The analogy of the finance member is apt because the public mind is far more financially sensitive and sane than scientifically acute and trained. Indeed, these councils themselves are almost certainly more awake to finance than they are to science. Is there not a House of Commons and a Press with money sense and taxation sensitiveness? But there is no similar power behind the scientific aspects of the case. It is not worth while to pose the false dilemma: which won the war, money or science? But it may be said that it is no use thinking the nation can safeguard its money if it does not safeguard its science. The awareness in money matters of the public due to its daily preoccupations, its annual state accountancy, etc., has ensured for money a representative at headquarters, but science has nothing of the kind.

No doubt the appeal of science would be better appreciated if it were expressed on terms of money. As an illustration of this the following episode is worth relating. The war council of a certain State was in session. A grave question had to be settled: advisers were outside the sacred chamber whence a member of council emerged, and, taking aside a man of science of European reputation who was in attendance and in the employ of that Army, propounded a question. As happens in such cases the inquiry sounded like: "How far is it from Somaliland to Good Friday?" so that the reply (and who has not gone through this ordeal!) began by hypothecating the alternative possible meanings and an inquiry as to which was intended. "I am not here to be interrogated but to be answered," was the reply inspired by a very proper fear of disclosing a clue to the secret policy in contemplation. The representative of science then gave an elementary lecture in which he reserved with dramatic instinct the essence of his reply for the climax. Before that was reached, however, the august member had excused himself and returned to his colleagues—fortified as a schoolboy would be for the reading of Plato by a knowledge of his subject limited to the alphabet. In the sequel some millions (not of marks) were expended on the scheme, which, however, was unfruitful.

Events and actions of this kind can be avoided only if the following principles are borne in mind:

(1) It is difficult even to ask for scientific advice so as to get it—unless the inquirer has scientific training.

(2) After asking for advice it cannot be taken without scientific training.

(3) When advice is taken it cannot be made effective without scientific training.

(4) However scientifically competent a man may be, he cannot advise on a case without knowing *à fond* how the problem arose and when, what qualifies it, and what alternatives might be employed to bye-pass the difficulty while still arriving at the goal.

It must be accepted that a genuine and thorough scientific training is not compatible with the multifarious changes of duty, changes of locality, changes of personnel, etc., essential to naval, military, and air force training. The development of a versatile, more or less uniformly trained force requires a *rota* of occupations by which officers and men, at stated periods of two or three years, are moved on to the various forms or classes which constitute the war school we call the Army, Navy, and Air Force. It is an accepted principle that no fighting man must become an indispensable expert; his loss would be too severe a discomfiture—his *ipse dixit* too formidable a threat to authority—his specialised training, and the unexpected bye-paths into which the laws of Nature would lead him, too incompatible with the whole principle of a versatile force of obedient and capable units united by a sedulously cultivated esprit de corps.

This is sound policy, and its acceptance leads to the conclusion that the scientific member of council cannot, any more than the finance member, be one of the routine organisation as we know it. We need scarcely plead here, after the War, that there is not, in a man of distinguished scientific attainments, any inherent unworthiness to be entrusted with State secrets. There is nothing peculiar about a suitably selected major-general that makes him a more acceptable recipient of such secrets than an equally well-chosen man of science. Nor yet is administrative ability incompatible with the widest range of scientific attainments.

The present-day divorce between the science which must infuse the war machine and the men who administer it is *not* of all time. Of old, as now, transport, communications, weapons, archery, etc., involved a knowledge of man's endurance, food consumption, horses, shoe leather, the elastic qualities of yew, the flight path of arrows, and the like, but then, unlike to-day, every member of the governing staff was easily an adept in these matters, competent to select and profit by any expert specialisation—when for a spell generals commanded the fleet they were soon discovered not to be adept and the sea was entrusted to those who were. In both cases it was unnecessary to provide a seat on the council for the astrologer, alchemist, or magician of the time. To-day, however, all this is changed.

It is not to be expected that even a carefully chosen and widely informed scientific member of council can know ballistics, meteorology, chemistry, metallurgy, the thermodynamics of the petrol engine, the intricacies of sound detection, or of wireless procedures, the stability of ships, the phugoids of aeroplanes, the rotary derivatives of their equations of motion, etc.; but given a really sound scientific representative none of these subjects is to him what most of them are to the Army Council, Admiralty, and Air Force Council—at the best, jargon: at the worst, stupidity. Such a man would and could seek advice, because he knows enough of the problem and of the outlook of science to see that it was wanted. He could take advice because he would know enough to sift it, test it, select it, and present it for consideration to a council with the real purpose and personalities of which he would be acquainted.

How can we make such a need be felt by the war machine, which is certainly not asking our advice about it? Only by public opinion; and clearly this is difficult. Scientific opinion deserves better regard and esteem than it gets, and it suffers this loss because of the quite unreasonable contempt with which it views the operations of politicians. The world of science abstains from making its voice heard in the only way it can be heard, through the megaphone of the politician, by reason of the pressure of its organisation. It has itself no organisation. Some of the wiser men, who lifted their heads from the absorbing interest of their own grindstones, did in fact form a Conjoint Board of Scientific Societies, which died a month ago. This body comprised the leading Institutions and Societies in the British Isles concerned with pure and applied science. It might have leavened the lump, and reminded the technical world that it is an organic part of modern social organisation. Let us hope, as taxpayers, if from no higher motive, that science and technology may yet form a federation to promote recognition of their significance in the affairs of the State.

Mervyn O'Gorman.

The Structure of the Atom.

The Theory of Spectra and Atomic Constitution: Three Essays. By Prof. Niels Bohr. Pp. x+126. (Cambridge: At the University Press, 1922.) 7*s.* 6*d.* net.

The beautiful conception which inspires and co-ordinates practically the whole of modern atomic physics is the atomic model of Rutherford and Bohr. Its essential feature—the nucleus—was first put forward by Rutherford in 1911 on the basis of experiments on the scattering of α-particles. So convincing is this model that after only twelve years it is known no longer as "the atomic model of Rutherford and Bohr," but is simply taken for granted as "the atom." In this development, moreover, the ideas of Bohr have played such a dominating part that it is of the greatest importance that the three essays of this volume should be accessible in English, as well as in the original Danish and German, to the widest circle of readers. We welcome most heartily their opportune appearance.

When a theory such as the present is expounded semi-historically by its principal creator, a critical account of the theory itself is scarcely the function of a review. Such a critical discussion could be nothing less than an exhaustive survey of the whole tendencies of modern physics. It is perhaps a less impossible—certainly a more relevant—task to attempt to bring to notice the various stages of the theory represented by the three essays in this book, in the hope that some faint reflections of their beauty and convincingness may be conveyed to those whose studies are directed elsewhere.

Some preliminary remarks of a general nature may not be out of place. Though the theory itself finds a place for much advanced mathematical analysis and demands the development of new and more powerful weapons than those yet available, in the hands of Bohr it is never an abstraction divorced from contact with physical realities. Rather he succeeds in bringing it ever into closer contact, and expounds it in these essays in a simple non-mathematical way which should be capable of being followed by any one who is prepared to accept the mathematical theorems on which the work is necessarily based. The mathematician will desire to look further into the foundations and will be rewarded. But those who are not mathematicians need not for that reason fall short of full conviction. It is unavoidable to speak of the theory, in description or exposition, as "explaining" certain facts of experience. But the theory is non-mechanical—in fact, is nowadays identical with the quantum theory—and "explanation" by the theory cannot mean explanation in the classical sense. Explanation of a fact can mean no more than its correlation with and co-ordination among an existing body of other facts which can all be similarly related to the same general principles; this, however, is enough. Beyond this we can ask for nothing less than a re-formulation of the whole principles of physics, which shall present both classical mechanics and electro-mechanics and the quantum theory as parts of a homogeneous whole. So far the divergencies between the two theories have become, if anything, rather more than less fundamental and mysterious, but the points of contact between the two theories, embodied mainly in Bohr's correspondence principle, have become ever more numerous and more sure. They are linked in a way which compels regard for them as two aspects of the same reality. It is the range and power of the correspondence principle, emphasising all these resemblances, which gives the theory its overwhelming appeal.

It is unnecessary to dwell on the first essay—"On the Spectrum of Hydrogen" (December 1913)—which presents, in a way now generally familiar, the suggestive but *ad hoc* arguments by which Bohr started the theory with such a combination of the ideas of Planck and Rutherford as to explain the spectra of the atoms of hydrogen and ionised helium and to promise an interpretation of the general laws of spectra. We pass to the second, "On the Series Spectra of the Elements" (April 1920), which breaks fresher ground. During 1913–1920 the theory had developed rapidly in its applications to subsidiary features of the hydrogen spectrum, which, besides Bohr and others, Sommerfeld, Schwartzschild, Epstein, and Debye took part in working out. It was extended to account with complete success for the fine structure of the hydrogen lines, and the effect thereon of external electric or magnetic fields. These advances can be summarised by saying that the way had been discovered for applying the quantum theory to a certain class of atomic systems of any number of degrees of freedom. This class is technically known as the class of quasi-periodic systems which permit of separation of the variables. Meanwhile Bohr put forward his correspondence principle, of which the germ is already present in the first essay, and the principle of mechanical transformability which he derived from Ehrenfest; principles which knit the foregoing results into a co-ordinated whole.

Briefly, the correspondence principle is this. If we expand the motion of a system in a series of sines and cosines of the time, a multiple Fourier series, in the complete radiation of the system demanded by classical theory a component of definite frequency, a definite "combination tone," will correspond to each term in the expansion. The correspondence principle asserts that there is a fundamental connexion between each "combination tone" and the possible switches from orbit to orbit, or changes of quantum number, which, on the quantum theory, give rise to radiation. In the limiting case of large quantum numbers there must be full agreement not only in frequencies but also in polarisations and intensities. This presents a rational means for extending the correspondence to all quantum numbers; every switch "corresponds" to a definite harmonic constituent in the mechanical motion of the atom. If any particular constituent is absent not only from the motion in the initial and final states but also from the whole family of mechanically possible motions, which are not themselves permitted orbits or stationary states but form a continuous transition between the initial and final states, then the corresponding switch will never occur. The complete success of this principle in accounting for details of the hydrogen spectrum is well known. A successful beginning has even been made by Kramers in the study by its means of relative intensities.

This, however, is only part of the ground covered by the second essay, which also applies these ideas to other spectra, in particular those of helium and the alkali metals. These sections must be read with Parts II. and III. of the third essay, which make important corrections. First, the assumptions of stationary states and the fundamental relation $E=h\nu$ between energy and frequency (first essay) explain naturally the combination principle of Ritz, for Ritz's "terms," the combinations of which are spectral lines, have now a physical meaning as the energies of the atom in its various stationary states. Consider a concrete example—sodium—with nuclear charge 11 and 11 planetary electrons. The inert properties of neon (10) indicate that we must suppose that the first ten electrons form together a very stable structure into which no further electron can be taken up on the same footing.

To a first approximation then, from the point of view of the eleventh electron, the effect of the first ten will simply be to modify the field in which it moves, so that, while its central symmetry is approximately preserved, the effective nuclear charge is a function of the distance from the nucleus, which is 11 at short distances and 1 at large. The same arguments hold for other alkali metals. If the exact law of variation of effective nuclear charge were known (numerically), the energies of all possible stationary states of the single external electron could be computed. We must, in any case, find that the set of stationary states forms no longer (as with hydrogen) a single series of terms depending on an integer n, but a double series depending on two integers n and k. We find that with absolute confidence we can identify the sharp terms with those for which $k=1$, principal terms $k=2$, diffuse terms $k=3$, and Bergmann (fundamental) terms $k=4$. Moreover, on the correspondence principle, only those combinations of terms will normally give rise to lines for which k changes by ± 1. This is precisely what is found to occur, and the puzzling incompleteness of Ritz's combination principle is entirely accounted for. There is, moreover, no real element of arbitrariness in this explanation, for the variation of the effective nuclear charge is of course due to the already bound electrons. These must lie in permitted orbits of definite quantum numbers which fit in with those of the spectral terms for an approximately central field of force, not very greatly modified from that which acts on the last electron. The numerical requirements of the theory can be satisfactorily met, and there remains no doubt that the atom must be regarded as fitting together in some such way. Perhaps this paragraph somewhat overstates the completeness of the theory as here expounded by Bohr, but it does not, I think, misrepresent it.

Besides its main contribution, the second essay also touches on and exhibits in their proper perspective other spectral facts—the spectra of ionised atoms, in particular those of the alkaline earths, with their Rydberg constant $4N$, which results naturally from the double residual charge with which the ionised atom controls its last electron; doublet and triplet separations, which arise from the deviation of the atomic field from central symmetry leading to the introduction of a third quantum number; finally, the unique nature of the helium spectrum with its absence of inter-combinations, of which an explanation in terms of a further generalisation of the correspondence principle may at least be said to be in sight.

These are mainly facts of which the explanation is still under development, but three further complete successes of the theory must also be recorded. The idea of stationary states accounts completely for the differences between emission and normal absorption spectra. An atom in its normal state can absorb only those lines for which the normal state is the initial stationary state of the absorption switch. For an alkali metal this means the principal series of doublets only—for an alkaline earth the principal series of singlets. In other cases, such as the aluminium subgroup, the theory leads us to expect that the normal state will correspond to the first principal term and that the absorption spectrum will be the sharp and diffuse series—an expectation recently confirmed by direct experiment. Secondly, the phenomena of resonance spectra are fully accounted for. Thirdly, the theory assigns definite energies to the various atomic states, and this assignment can be tested directly by the study of electronic impacts. This is by itself a complete branch of modern physics directly inspired by the theory, which it as directly and completely confirms.

The third essay, "The Structure of the Atom and the Physical and Chemical Properties of the Elements" (October 1921), is the most novel and important of the three. It differs from the others in being slightly revised in translation to bring it up-to-date (May 1922). This essay brings the whole of the available evidence—X-ray, chemical, optical—to bear on the specific question of the structure of the atom; that is, the way in which the planetary electrons are arranged. We have already seen that this is implicitly discussed, and a definite view reached, in connexion with the theory of series spectra. Other evidence merely confirms and crystallises this view. The goal to be attained is the theoretical deduction, from the principles of the quantum theory properly formulated, of the periodic table of the chemical elements, and all other atomic properties. Bohr shows that the fundamental process which must be considered is the successive binding of electrons one after another by a nucleus originally naked, and that, if we could say what would be the final orbit of the nth electron bound by a nucleus of charge Z, we could deduce the general features of the periodic table and other atomic properties in the desired manner. He shows that already we know, partly theoretically, partly empirically, a very great deal about these binding processes. The arguments cannot usefully be summarised. The result is that we can specify with considerable certainty the two principal quantum numbers, n and k, of the orbits in most atoms. The orbits thus fall into a number of groups, and we know the number of equivalent orbits in each group. The groups of orbits are arranged with various types of spatial symmetry; they must on no account be thought of, as in earlier models, as forming coplanar rings of electrons. The systematic study of X-ray levels begun by Kossel in the field opened up by Moseley has played a leading part in this development.

There are two crucial points to be emphasised in the present position of the theory, which can best be stated as questions. *Can we deduce from the quantum theory the particular points at which a group of electronic orbits fills and a new group starts?* In particular, can we prove that the third electron in the lithium atom must remain in a new type of orbit ($n=2$, $k=1$) and not fall into an orbit equivalent to those of the first two electrons ($n=1$, $k=1$)? Secondly, *can we deduce from the theory the regular sequences of physical and chemical properties, together with their occasional interruption for groups of homologous elements such as the iron group or the rare earths?* It can scarcely be said, and Bohr, I think, does not claim that an unqualified "yes" is yet the answer to the first question; but putting the question is itself a great advance, and the lines on which an answer will be forthcoming are already clear. It seems certain that the impossibility of the third electron getting into a 1-quantum orbit is of the same nature as the impossibility of intercombinations in the helium spectrum or of the two coplanar electrons of the orthohelium spectrum getting both into coplanar 1-quantum orbits. These impossibilities seem to be connected with the absence of any coherent class of mechanically possible orbits which continuously connect together the initial with the desired final state, but the absence of such classes is scarcely yet established.

Granted the answer "yes" to the first question, the answer "yes" in general terms can now be given fairly to the second, though of course only a fraction of the interesting points of detail have yet been worked out. It can already be stated definitely that, for example, the iron group accompanies the establishment of orbits of type ($n=3$, $k=3$) in the normal atom which (it is almost a direct deduction) appear for the first time at scandium. They occur in the fourth period and differentiate it from the second and third because there for the first time is it arithmetically possible for successive atoms to differ by an extra electron in an inner orbit instead of in an external one. In the same way the rare earth group is associated with the development of orbits of the type ($n=4$, $k=4$), the outer orbits consisting of both 5-quantum and 6-quantum orbits, the same in number and much the same in form from atom to atom.

It is a great theory and a great work. Its most fruitful stages are yet to come.

R. H. Fowler.

Religion and Evolution.

The Religion of Science. By Prof. William Hamilton Wood. Pp. xi+176. (London: Macmillan and Co., Ltd., n.d.) 6*s*. net.

At the present time it is especially interesting to compare the way in which, in different parts of the world, thoughtful men regard the relation between religion and science. We should expect to find a general uniformity in the different attitudes of representative thinkers in Great Britain and America. We are largely of the same stock. We speak substantially the same language, so that books in large numbers pass in both directions across the Atlantic. But it is a curious fact that the popular religious dislike of evolution, which even enters into politics in the Middle Western States, affects leaders of American thought. No theologian of eminence in England would now challenge a scientific conclusion, for which experts combine to demand our assent. Yet, in the book before us, the professor of biblical history and literature in a college at Hanover, N.H., makes a vigorous attack on "the religion of science," and argues that man cannot be fitted into the scheme of biological evolution. *No fossil or organic half-man*, says the professor in impressive italics, *has ever been discovered, and never will be.* (Grammatically the final clause means the opposite of what the professor intends; but we will let that pass.)

Most readers of Nature will be tempted to say at this stage, "The man's a crank. No need to read further." But the judgment would be unjust. Prof. Wood, though his literary style is at times painful, has clearly given close thought to the problems which he discusses. As against certain views expressed by American writers, in works with which we are unfamiliar, he argues acutely. He shrewdly exposes the illegitimate metaphysical assumptions of the "science-theology," which we should agree with him in condemning. But he has not apprehended the larger synthesis generally accepted by English theologians. Because his outlook is too limited, the theory of evolution seems to him to eliminate "God as a real existence and personality." So to preserve religion he rejects evolution.

This apparent necessity could not arise were there not a latent dualism in his thought. Christian theology in the third century took over from Neoplatonism a belief in the unity and solidarity of the universe. This belief, of course, is in fundamental harmony with the teaching of Christ. Failure to preserve it intact in all its implications is the source of most of the difficulties which have troubled Christian divines in their warfare with "science-theology." Prof. Wood is really following a degenerate tradition when he opposes the "natural" to the "supernatural" instead of pleading that in all Nature spiritual activity is manifest. His dualism causes him to speak of, "on one side, the non-moral development of the universe which is continuous, while within this, or related to it, is the moral evolution terminating in man." He can also say, "The main point is not whether mankind came originally from a single pair or was spawned like larvæ, nor is it our simian ancestry. It is that man is a derived and, therefore, secondary product." We need not comment on the biological character of the first sentence; but we would ask, Why should the derived product of the harmonious working of a universe, informed by Spirit, be secondary? Surely we should expect the creative activity of Spirit to work towards something of which it is the archetype; or, in more familiar language, that God has, by the slow process of evolution, created man for communion with Himself.

Prof. Wood does not see that, if Christian thinkers can justify their belief that the whole world arose and took its pattern because of the creative activity of Spirit, they need not quarrel with evolution. On the contrary, the biological doctrine then becomes a description of the way in which Spirit has worked; and, by interpreting it, we get an understanding of the nature of spiritual reality. By tacitly opposing Nature and Spirit the professor finds it difficult to resist the conclusion that "the original and primal is the real." But if we are convinced that the process "from nebula to man" reveals Spirit working in time, we shall see, in Nature, degrees of reality which have successively emerged, the last being the consciousness of civilised man.

How can we meet the contention that there is no such reality as Spirit? We answer that the fundamental objection to the naturalism, which Prof. Wood terms science-theology, is that it is inconsistent with itself. It makes spiritual judgments while denying spiritual reality. Science, within its proper sphere, is quantitative. In it the mind abstracts those aspects of Nature which can be measured. But then the mind forms scientific concepts "in which the phenomena given in perception attain to a higher degree of coherence and of truth." We prize these concepts because of their truth-value. But value-judgments belong to the world of spirit, to a kind of existence to which merely numerical categories do not apply. To the same spiritual world such qualities as justice and virtue belong. Strictly speaking, they lie outside the realm of natural science. Men of science are always, often unconsciously, interpreting their results by means of value-judgments. Such a phrase as "the survival of the fittest" is a well-known example of this process. For the explanation of a thing or an event we have to use what is above it in the scales of existence or value. Yet, in spite of this, men of science who are constantly studying properties of matter, living or dead, jump to the metaphysical conclusion that matter is ultimate reality. The legitimate conclusion is rather that ultimate reality is spiritual, and that goodness and beauty, like truth, reveal its nature.

The relation of matter to spirit continues to perplex us. But the tendency of modern physics is increasingly to reduce matter to a mere metaphysical abstraction, like the ether, which is the subject of energy. Some physicists appear to regard matter as nothing but a form of energy. But neither view will allow us to regard the universe as a self-acting machine, for in such a conception mind can have no place. Moreover, as soon as natural science ceases to be merely descriptive, the idea of causation enters in. We cannot explain cause unless we admit creative action working towards a definite end, so that the laws of Nature express the uniform mode of action of a Supreme Will. The doctrine of evolution indicates the purpose of that Will, for it asserts that earth's life-process has led to man, whose conscience tells him that he must be loyal to absolute values external to himself. God, in short, reveals His own nature in the highest faculties of humanity.

It cannot, we think, be fairly argued that belief in evolution destroys the Christian hope of eternal life. That hope rests ultimately upon belief in "the conservation of values," upon a conviction that the attributes of God are eternal with Him. We now know enough of the universe to be sure that within a measurable period life upon this earth will come to an end. All humanity's spiritual achievements will then perish unless there is a Kingdom of Heaven where they are eternally preserved. Among such achievements the perfecting of personality ranks highest. It is difficult to conceive either of timeless existence or of a perfect human soul; but the reasonableness of our hope of eternal life is not thereby destroyed. Significantly Christianity connects belief in human immortality with its doctrine of the Incarnation, its affirmation that, in a perfect Man, God has actually been revealed.

We can do no more than hint at our reasons for disagreeing with Prof. Wood's point of view. But, because we have criticised his views, we would commend his honesty, his freedom from bigotry, and the high seriousness of his aim. The problems which have engaged his attention are as difficult as they are vital. It is probable that humanity will never solve them completely; it is certain that now we can but see "as in a glass darkly."

E. W. BARNES.

A Peruvian Desert.

Geology of the Tertiary and Quaternary Periods in the North-west Part of Peru. By Dr. T. O. Bosworth. With an Account of the Palæontology by H. Woods, Dr. T. W. Vaughan, Dr. J. A. Cushman, and others. Pp. xxii+434. (London: Macmillan and Co., Ltd., 1922.) *2l.* *5s.* net.

THERE are few contributions to geological science, published in recent years, of greater value than this description of some three thousand square miles of the littoral of northern Peru.

Dr. Bosworth, who was formerly in the British Geological Survey, was still a young man when he left it to take up economic work, but he had already made himself a name for sound and original geological research. The present publication is not the result of a rapid traverse of the area with which it deals, but is the fruit of several years of exploration, reinforced by detailed surveys in many places and numerous borings for oil, in which the characters of the strata traversed were carefully observed. Dr. Bosworth has had one great advantage; the desert conditions that prevail expose clearly to view much more of the characters and structures of the rocks than meets the eye in more fertile regions. At the same time, he has spared no pains to make his work as complete as possible. In order that the fossils collected should be properly described he has enlisted the services of a number of the leading palæontologists in this country and America, and their descriptions, figures, and conclusions are given in full.

The district described rarely exceeds a thousand feet in height above sea-level. It lies between the Pacific and a background of the Western Andes, which consist of pre-Tertiary rocks folded under the stresses of the zone of compression that encircles the greatest in the immediate neighbourhood of the shore, raised above its previous level. It was at the same time broken up into numerous blocks separated by minor faults, often of considerable throw, constituting a kind of fault breccia on a gigantic scale.

In this aggregate of dislocated sediments the action of the sea, assisted by subaerial agencies, excavated a broad, nearly horizontal shelf, which reached to the foot of the mountains, and became submerged sufficiently to allow of a new series of deposits being laid down upon it, which must be referred to the Quaternary Period, as they contain remains of forms identical with those living in the adjoining sea. Then a period of elevation supervened, and the former sea-floor was exposed to view as a nearly level plateau—a *tablazo*,

Fig. 1.—Ridge-and-furrow topography, produced where the strike of the beds is in the same direction as the prevalent wind. From "Geology of the Tertiary and Quaternary Periods in the North-west Part of Peru."

of our oceans. The latest strata involved in the folds are of Cretaceous age, and it must have been after their deposition that these mountains were raised up and exposed to the destructive activities of sun, wind, and running water, and in all probability frost and ice as well. From the debris a great succession of sedimentary strata of Tertiary age were accumulated to a thickness of some 20,000 feet on the slowly subsiding ocean floor, not without important breaks in the succession, for only the Eocene and Miocene are represented.

The denudation of the mountains and the accumulation of the sediments over a broad tract on the margin of the Pacific appear to have destroyed the isostatic balance that had previously existed and created a state of strain which finally resulted in a great fracture off the coast, the western side being thrown down deep below the surface of the sea, and the eastern, which included such of the Tertiary deposits as were as it is called locally—and it still remains in many places almost in the same condition as it was when the sea left it. Its western margin was now attacked by the waves and a second shelf was carved out, which was covered by another series of deposits, and afterwards raised to form a second *tablazo*. Still another *tablazo*, possibly more, would seem to have come into existence in the same manner. The last tracts to be raised from the sea were the *salina* or salt plains, which are scarcely above the reach of the spring tide. Indeed, some parts are occasionally submerged. Remains attributed to the Incas are found upon them, and some of the land a few hundred yards from the high-water line has been irrigated, apparently by them. It would seem therefore that there can have been no appreciable change of level since the coming of the Spaniards. The author infers that not a ten-thousandth part of the Quaternary history can have elapsed in the last five hundred years. This would give Quaternary time a duration of at least five million years, which seems an over-estimate. In all probability the rise of the land has not been continuous, but rapid movements of elevation have alternated with long ages of quiescence, while the occasional periods of submergence may be explained by a slow continuous rise of the ocean level, such as is believed by Daly to have taken place in the Pacific. It is worthy of note that there appears to be no evidence of any renewal of compression since that to which the mountains owed their formation in late Cretaceous or early Eocene times. This suggests a doubt as to whether the westward movement of South America, postulated by Wegener, can have continued far into Tertiary times.

There is not space to follow the author in his description of the climatic conditions in the desert; of the effects of the rare torrential rains and the slow desiccation that succeeds; of the deeply cut valleys, the breccia fans, and the valley and marine terraces; of the work of sun and wind, and of the scanty animal and vegetable life; except to say that the book should take its place beside the writings of Walther and Cloos in the libraries of all students of the desert.

The concluding chapters contain a useful account of the petroleum deposits of the area, in which oil-wells have been sunk to a depth of 4000 feet. Valuable information is afforded as to the stratigraphical range of the oil, and the history of its exploitation is described; but it is unfortunate that in deference to the wishes of the International Petroleum Company no detailed account of the main oil-field is given. "With the exception of a few general comments, sanctioned by the Company, the development and conclusions of the past eight years are excluded from this description." Considering how much the great industrial organisations owe to science, one would expect from them a little generosity, even a little sacrifice of material advantage, if such be required, that they may repay their debt to research by adding their quota to the general fund of human knowledge.

Fig. 2.—"*Rabo de Leon*" growing among blocks of quartzite in the Amotape Mountains. (The height of these plants here is about 3 feet.) From "Geology of the Tertiary and Quaternary Periods in the North-west Part of Peru."

It only remains to state that the book is excellently illustrated by numerous sketches and reproductions of photographs (two of which are given here) and by clearly-drawn maps, plans, and sections.

John W. Evans.

Our Bookshelf.

Aspects of Science. By J. W. N. Sullivan. Pp. 191. (London: R. Cobden-Sanderson, 1923.) 6*s.* net.

Most works on that department of thought which lies on the frontier between philosophy and science should be included by pharmacologists among the class of narcotic drugs. As narcotics they are very effective, for they induce oblivion rapidly and profoundly, and they have the great advantage of being without any of the undesirable—or other—after-effects that are common with such drugs. Notably, they have not the great drawback of most narcotics of inducing a craving for the constant repetition of the dose. Perhaps this character is partly determined by the circumstances in which these works are mostly used. Observation will confirm the general impression that such books are largely resorted to by elderly men of science, after working-hours, in the fastnesses of club libraries or by the domestic fireside. Mr. Sullivan's book is, however, useless for such purposes, for he defies slumber!

We do not remember to have read in English anything on the philosophical implications of science comparable to this little book for its wit. Easy writing is said to make hard reading, and, if the converse is true, an immense amount of labour must have been thrown into this series of very short chapters. Short though they are, many of them leave a feeling of remarkable completeness, and some of them, such as those on "Assumptions in Science" and "The Sceptic and the Spirits," are really little masterpieces in which we feel Mr. Sullivan has said the last word in the present state of knowledge.

There are many books on the nature of science and on its philosophical and ethical relationships, but there are very few that will appeal to younger people. Mr. Sullivan has, however, produced such a work. It can be safely placed in the hands of any student; most of it can be understood by any intelligent boy or girl of the age of sixteen; it is always challenging without ever being dogmatic, and witty without ever being cruel or "cheap." Any scientific man with the slightest philosophical bent must find this work stimulating and refreshing, and it is obviously written by one with a remarkably wide working knowledge of science.

C. S.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Abt. IX: Methoden zur Erforschung der Leistungen der tierischen Organismus. Teil 4, Heft 1: Methoden der Erforschung bestimmter Funktionen bei einzelnen Tierarten. Lieferung 76. Pp. 122. (Berlin und Wien: Urban und Schwarzenberg, 1922.) Grundzahl: 4·8 marks.

THE new section of Abderhalden's invaluable "Handbuch der biologischen Arbeitsmethoden" contains a very useful résumé of methods for the study of digestive secretions in the lower forms, an account of the technique of gonadectomy and transplantation of germinal tissue in insects, together with a rather longer review of experimental procedure in the study of pigmentary responses. This section, by Dürken, suffers, like the author's recent "Einführung in die Experimentalzoologie" (1919), from a complete disregard of the large volume of experimental work on amphibian metamorphosis and the illuminating observations on colour response which have emerged from it during the past eight years; consequently it deals exclusively with methods for studying factors which induce pigmentary responses rather than the mechanism which co-ordinates them. Perhaps it is inevitable that such omissions should occur owing to the economic handicaps under which scientific workers are pursuing their labours in Central Europe at the present time. Still, it is difficult to believe that the author of the "Methoden zum Studium des Pigmentwechsels" had no opportunities of consulting the extremely important work of Spaeth, Redfield, Smith, Allen, Laurens, and Swingle, none of whom is mentioned in his survey, though there have been since 1918 few numbers of the *Journal of Experimental Zoology* which do not contain some contribution to the physiology of pigment response in amphibia, reptiles, or fishes.

Infant Mortality. By Dr. Hugh T. Ashby. Second edition. (Cambridge Public Health Series.) Pp. xii+224. (Cambridge: At the University Press, 1922.) 15*s*. net.

BY "infant mortality" is meant the ratio which the number of infants who die in any one year bears to the number of births in that year. The rate for the country generally remained more or less stationary until 1905, since when, however, it has steadily decreased, so that during the last two or three years it has been only about half that which obtained in the late nineties of last century. Infant mortality is of enormous national importance, for with the present low death-rate, which it will be difficult in the future materially to reduce, and a falling birth-rate, now only about two-thirds what it was at the end of last century, the maintenance of our population will largely depend upon the survival of as large a proportion as possible of the infants born.

The appearance of a second edition of Ashby's "Infant Mortality" is therefore opportune. The practical side of the question has been kept in view throughout, and purely medical technicalities have been omitted. The condition is a very complex one, but an attempt is made to ascertain its main causes; one of these, summer diarrhœa, has been practically suppressed. The number of still-births and the mortality during the first week of life are still far too high, and their causes merit further investigation. Maternal mortality shows an actual increase of late, and needs to be taken seriously in hand.

The author has skilfully marshalled his facts, and the chapter on the means by which infant mortality may be further reduced gives an excellent summary of the subject.

Pests of the Garden and Orchard. By Ray Palmer and W. Percival Westell. Pp. 413+47 plates. (London: Henry J. Drane, Farringdon Street, n.d.) 25*s*. net.

IN the work under notice the authors have aimed at meeting the needs of practical agriculturists and horticulturists by collecting into one book all the available information on plant pests and diseases necessary for their guidance. Insects and other animals, fungus diseases and weeds, are all dealt with categorically under their separate headings, a short description and the methods of treatment being given in each case. Many of the numerous illustrations are very clear, but others are scarcely sharp enough to prove efficient aids to identification.

Among other useful features special attention may be directed to the detailed formulæ for sprays, with antidotes to the various poisons used in their composition, and also to the identification and spraying tables for insect pests and plant diseases. For identification these are classified under the heading of the plant attacked, and the chief features of each are indicated with reference to the further descriptions in the text, whereas the spraying tables summarise the applicable methods of treatment with instructions as to the time they should be carried out. Altogether the practical man, and others, will find this a most useful handbook for obtaining much of the necessary information that is otherwise very scattered.

Business Geography. By Ellsworth Huntington and Prof. F. E. Williams. With the co-operation of Prof. R. M. Brown and Lenox E. Chase. Pp. x + 482. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 13*s.* 6*d.* net.

The authors intend this volume to be used after a course on commercial and industrial geography. It deals with the principles of geography, the effect of specific geographical factors, types of human communities, and the trade and commerce of the continents, with more detailed consideration of the United States. The book is a welcome addition to the volumes already available on the geography of production and commerce, and in its width of outlook and wealth of ideas should prove very stimulating, and occasionally provocative, to all readers. In one essential respect it differs from most books on the subject: the human factor in business relations receives ample consideration. The world is treated not merely as so many places, each producing so many products: the varying physical and mental qualities of races are recognised and given their due weight in the explanation of the development of the world. Stress is also laid on the relation of man to different climates in respect of wealth and efficiency. The book is admirably illustrated, and there are a number of ingenious exercises attached to each chapter. It is a book that should find wide acceptance in spite of its unattractive title.

Practical Colour Photography. By E. J. Wall. Pp. vii + 248. (Boston, Mass.: American Photographic Publishing Co.; London: H. Greenwood and Co., Ltd., 1922.) 13*s.* 3*d.*

The representation of colour, in addition to form and light and shade, by photographic means is a subject that has been allowed to get very far behindhand so far as text-books of photography are concerned. Mr. Wall's volume is therefore very welcome as doing a great deal towards filling this gap in photographic literature, which has been automatically increasing for many years. It does not quite fill the gap, for photo-mechanical methods are not treated of, historical and theoretical data have been, so far as possible, omitted, and the scope of the work has been restricted by the fact that all methods and formulæ given have been personally tested in practice. But within the limits indicated it is surprising how many methods there are of representing colour. Of three-colour processes there are the carbon and gum bichromate processes, the imbibition of dyes, mordanting processes, the bleach-out process, and the use of screen plates (autochrome, Paget). Of what may be called direct processes there are the interference heliochromy of Lippmann, the use of "silver subchlorides," and the diffraction and prismatic dispersion processes. Finally there are two-colour processes, and those adapted specially for cinematography. The book forms an excellent practical introduction to the subject.

Le Négatif en photographie. Par A. Seyewetz. Deuxième édition, revue, corrigée et augmentée. (Encyclopédie scientifique: Bibliothèque de Photographie.) Pp. viii + 308. (Paris: Gaston Doin, 1923.) 15·40 francs.

M. Seyewetz is chiefly known to us by the researches that he has carried out, often in conjunction with M. M. Lumière. One naturally expects an author to treat more fully of those subjects that he has personally studied. In the present case this is a distinct recommendation, for the author's investigations have been so largely connected with the processes involved in negative making. The summaries of the characters, use, and effects of the various developing agents are especially valuable. It is of interest to notice that M. Seyewetz is not one of those who believe that development is a mechanical process which cannot be varied except to the detriment of the negative. The paper and the quality of the illustrations of this volume show that our neighbours have not recovered so far as we have in this country from the detrimental effects of the War, but these matters do not detract from the sterling character of the volume.

Practical Handbook on the Diseases of Children: For the Use of Practitioners and Senior Students. By Dr. Bernard Myers. (Lewis's Practical Series.) Pp. xvi + 548. (London: H. K. Lewis and Co., Ltd., 1922.) 21*s.* net.

The important subject of diseases of children is one which is too often neglected in the curriculum of the medical student. Dr. Bernard Myers has produced a handbook in which he has treated the subject mainly from the practical side. He has adopted the usual arrangement of considering anatomy and physiology first, then clinical investigations and the diseases of the various systems. Articles have been contributed by experts in their special branches, *e.g.* biochemistry, serum therapy, physiology of digestion, and syphilis. Some confusion may arise from the separation of nutritional disturbances from affections of the stomach and intestine, and also from the classification of nutritional disturbances as "failure to gain," "dyspepsia," "decomposition," and "intoxication."

The moderate size of the book, its concise descriptions and practical aspect, combine to make it a useful addition to the student's text-books and the practitioner's library.

Religion and Biology. By Ernest E. Unwin. (Christian Revolution Series, No. 15, Pp. 185.) (London: The Swarthmore Press, Ltd.; New York: George H. Doran Co., 1922.) 6*s.* net.

This work, written from the point of view of a member of the Society of Friends, is an attempt to outline the biological approach to questions of religious thought, and should be of use to school teachers. The author believes he has a message for biologist and schoolmasters. His gentle and spiritual point of view never raises opposition, and the book will be found of value for the purpose for which it is designed.

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.*]

Crystal Structure of Basic Beryllium Acetate.

PROF. G. T. MORGAN recently sent me some well-formed crystals of basic beryllium acetate $Be_4O(C_2H_3O_2)_6$, suggesting that their analysis by X-ray methods would, in all probability, be of considerable interest. The results show, I think, that the anticipation was well founded.

The molecule is a perfect tetrahedron. The crystal structure is that of diamond, a molecule replacing each atom of carbon. The carbon atom is itself tetrahedral, but is very nearly a sphere. The slight departure from sphericity is shown by the presence of a very small second order in the reflection by the tetrahedral plane of diamond. In the acetate this effect is large, because the tetrahedral character is so much more pronounced than in the carbon atom.

The oxygen atom must be at the centre of the tetrahedron. The beryllium atoms lie on the lines from the centre to the corners; and each $(C_2H_3O_2)$ group must be associated in a very symmetrical manner with one of the tetrahedron edges.

Prof. Morgan and I hope to give, at a later date, a fuller description of the analysis, and to discuss the inferences that may be drawn from it.

W. H. BRAGG.

A Theory of the Viscosity of Liquids.

As is well known, the viscosity of gases and its variation with temperature has received a satisfactory explanation on the basis of molecular theory. Little progress has, however, been made towards explaining the phenomena of the viscosity of *condensed* media—that is, of liquids and solids from a molecular point of view. What is evidently required is a working hypothesis which will indicate why, when a substance passes from the state of vapour to that of liquid, its absolute viscosity is greatly increased but *diminishes* with rising temperature, while that of the vapour *increases* in the same circumstances. I propose in this note to put forward briefly the outline of a theory which appears to have claims to serious consideration, as it indicates a quantitative relation between the viscosity of a liquid and of the corresponding vapour which is supported by the experimental data.

The manner in which transverse stress is propagated through a material medium is known in the cases in which the substance is in the state of vapour and in that of a crystalline solid. In the former case, momentum is transferred through the diffusion of the molecules between parts of the medium in relative motion, and this is a relatively slow process. In the crystal, on the other hand, the stress is transmitted in the form of transverse elastic waves, and the latter process, at least for ordinary displacements, is extremely rapid. We may conceive that in a liquid, momentum is transported partly by the first process and partly by the second, and that the effective viscosity depends on their relative importance. The ratio in which the two modes of propagation are operative may be determined from thermodynamical considerations, combined with certain simple suppositions regarding the constitution of a liquid.

We shall assume that the state of aggregation of the molecules in a liquid is of a composite character: some of the molecules are quite free to move, and may be termed "vapour" molecules; the others are attached to each other somewhat as in a crystal, and may be termed "crystalline" molecules. In determining the proportion of the two types, we shall consider only binary encounters between molecules. Let E_1 be the work required to separate a pair of molecules of the first type, and E_2 those of the second type. Then applying Boltzmann's distribution law, we may, as a first approximation, take the relative proportion of the two types of aggregation in the dissociation equilibrium to be as $e^{E_1/RT}$ to $e^{E_2/RT}$, where R is the gas-constant and T the absolute temperature. The next step is to determine the rate of transport of momentum through the medium. In the "vapour" part of the aggregation, the transport occurs by bodily movements. In the "crystalline" part, the rate of transport may be considered to be practically infinite. The effective rate of transport in the liquid is therefore greater than in the vapour at the same temperature and pressure in the ratio $e^{E_2/RT}/e^{E_1/RT}$. The viscosity of the liquid is therefore given by the formula $\eta_{\text{liquid}} = \eta_{\text{vapour}}\, e^{(E_2 - E_1)/RT}$. Since $E_2 > E_1$ it follows that the viscosity of the liquid will *diminish* with rising temperature.

The next step is to determine the absolute magnitudes of the energy constants E_1 and E_2. As was first pointed out by Sutherland, in the cases of gases and vapours the attractive forces between the molecules tend to *increase* the frequency of collisions and thus *diminish* the viscosity. The matter has been further examined by Chapman, who has shown that Sutherland's constant is one-sixth of the mutual potential energy of the molecules when in contact. It is convenient to use an amended form of Sutherland's formula and write

$$\eta_{\text{vapour}} \propto T^{\frac{1}{2}}\, e^{-E_3/RT},$$

where E_3 is another energy-constant. From Chapman's work it would appear that $E_2 = 6E_3$, and we may also take $E_1 = E_3$. Hence, finally, we have

$$\eta_{\text{liquid}} = \eta_{\text{vapour}}\, e^{5E_3/RT}.$$

E_3 may be found from the data for the viscosity of vapour at different temperatures, and the formula thus enables the viscosity of the liquid to be calculated *a priori*.

To illustrate the matter, it will suffice to take the case of benzene as an example. The table shows the viscosity of liquid benzene at different temperatures as determined by Thorpe and Rodgers, and also as calculated from an empirical equation of the type $\eta = Ae^{B/T}$.

VISCOSITY OF BENZENE LIQUID.

A = 0·0000951. B = 1237.

Temperature.	Calculated Viscosity.	Observed Viscosity.	Difference.
7·67°	0·00781	0·00789	+8
13·46	0·00714	0·00717	+3
19·39	0·00654	0·00654	0
25·96	0·00595	0·00595	0
32·07	0·00549	0·00547	−2
38·47	0·00504	0·00502	−2
45·35	0·00464	0·00461	−3
51·66	0·00429	0·00429	0
57·37	0·00403	0·00402	−1
63·29	0·00377	0·00377	0
69·41	0·00353	0·00354	+1
73·36	0·00332	0·00333	+1

Viscosity of benzene vapour at 100° C. = 0·0000930.
$5E_3$ calculated from the value at 212·5° C. is 1300.

It will be seen that the formula represents the viscosity of the liquid within an average error of 2 parts in a thousand; and that the constants A and B are in fair agreement with the values calculated from the data for the viscosity of the vapour. An empirical formula of the type $Ae^{B/T}$ is found to represent closely the variation of the viscosity of many liquids, especially at the higher temperatures. As we have assumed that the "vapour" molecules are identical with those actually found in the gaseous state, we cannot expect the experimental constants A and B to agree exactly with those indicated by the theory outlined in this note in all cases. Considerable deviations actually occur in the case of "associated" liquids, in which presumably the effect of the molecular fields of force cannot be handled so simply.

The further discussion of this question and of the extension of the theory to the case of dense vapours on one hand, and to supercooled liquids and amorphous solids on the other hand, offers a most interesting field of research. The treatment suggested can obviously be improved in several directions, especially in the discussion of the dissociation equilibrium between the two types of molecules, and the effect of high pressures on the viscosity of liquids could probably be explained by a more exact investigation.

C. V. RAMAN.

210 Bowbazaar Street,
Calcutta, India, March 1.

Colour Temperature and Brightness of Moonlight.

OUR more complete knowledge of full or black-body radiation embodied in Planck's law makes it possible to speak of the temperature of radiation as well as the temperature of radiating bodies. Thus, the temperature of any visible radiation is the temperature to which a black body must be raised to emit light as nearly as possible of the same integral colour or quality as that of the radiation in question.

The necessary "colour matches" involved in comparisons of a given radiation with that of a black body at a known temperature may be easily and quite accurately made with a contrast photometer. Radiation temperatures thus determined are called "colour temperatures." The colour temperature of the zenith sun as seen from the earth, according to Abbot's bolometric data, which extend into the infra-red spectrum, is 5600° abs. If correction is made for the absorption of the earth's atmosphere, we get a value of 6500° abs. for the colour temperature of sunlight above atmospheric limits. When a contrast photometer is used for making "colour matches" to determine colour temperature, a black-body source at a corresponding temperature is necessary for comparison. To avoid the necessity of a comparison black body at very high temperatures, advantage can be taken of Planck's formula for black-body radiation for computing a distribution of intensities in the visible spectrum which will give the integral colour of the source under examination, as measured by an optical pyrometer with monochromatic screens.

This procedure was followed in some observations made to determine the colour temperature of moonlight. The disappearing filament pyrometer with blue and red glass screens was focused on one of the brighter portions near the centre of the full September moon, 1916, when near the meridian. These readings were repeated under nearly the same conditions a year later. The colour temperature found for moonlight on the two evenings in question agreed to within 50°.

With the same pyrometer data we can also determine the brightness temperature of the moon for a given wave-length; that is, determine the temperature of a black body which has the same brightness or intensity for the same small wave-length interval chosen for comparison. Thus, with a red glass screen transmitting an average or effective wave-length of 0·665 μ, we may determine the brightness temperature of the moon for this wave-length. It is also possible, from the data thus obtained and the brightness of a black body, to calculate the brightness of the moon in candles per square centimetre. Thus, knowing the illumination due to the sun, the reflecting power of the moon for sunlight may be calculated.

The data determined from these various observations and calculations are shown in the following table:

Colour temperature of moonlight .	4125° abs.
Brightness temperature ($\lambda = 0{\cdot}665\,\mu$)	1575° abs.
Brightness for total light . .	0·25 candles/cm.^{2}
Reflecting power for total light .	0·07

The difference in colour temperature between the sun and sunlight reflected from the moon, 5600° and 4125° respectively, indicates that the observed area of the moon reflects selectively, the coefficient being about twice as large at the red end of the spectrum as at the blue. The greater difference in brightness temperature of these two is due to the low albedo or average reflecting power of the moon's surface.

W. E. FORSYTHE.

Nela Research Laboratories,
National Lamp Works,
Cleveland, Ohio,
March 21.

Botanical Aspects of Wegener's Hypothesis.

IN the account which appeared in NATURE of January 27, p. 131, of the discussion on the distribution of life in the southern hemisphere, which took place before the Royal Society of South Africa, I am said to regard the botanical evidence as completely opposed to Wegener's theory. The remainder of the article generally followed the official report issued by the society.

My point was that the ancient phyla, with excellent means and ample time for dispersal, are generally valueless as indicating former land connexions. On the other hand, the distribution of the modern groups, especially the Angiosperms, in the South Temperate sub-continents took place in the main after the disruption envisaged by the Wegener theory. Thus neither ancient nor recent groups give us any material assistance in criticising this suggestive hypothesis, so far as concerns the relationships between the South American, South African, and Australasian floras. The botanical evidence for the southern hemisphere is certainly not "completely opposed" to Wegener's theory: it simply does not provide any critical test of that theory, so far as I can see at present.

R. H. COMPTON.

National Botanic Gardens,
Kirstenbosch, Newlands,
Cape Town,
February 26.

I ACCEPT Prof. Compton's correction of the phrase "completely opposed"; it is perhaps too strong a term to have used. Prof. Compton's letter, however, at least admits that the evidence from the botanical side is valueless as a critical test for or against

Wegener's hypothesis, and emphasises the fact that supporters of that hypothesis must look elsewhere than to the facts of animal and plant distribution for positive evidence in its support. Zoologists and botanists are dependent on the geologist and geophysicist for the correct interpretation of the palæogeographical changes which have taken place in the earth, and must be guided by them in selecting the basis on which the known geographical distribution of living forms can be explained.

THE WRITER OF THE ARTICLE.

Use of the Triode Valve in Spectrometry.

THE three-electrode valve offers a very simple and trustworthy method of amplifying the small currents produced in the thermopile of an infra-red spectrometer. Bright lines are more readily picked up and the limits of absorption bands determined with greater certainty with a valve and telephone than with a galvanometer. Moreover, the valve is instantaneous in action, while a sensitive galvanometer takes an appreciable time to give a trustworthy indication—so much so that the fainter lines are apt to be missed when using a long-period galvanometer. In the thermopile circuit an interrupter is necessary: this may take the form of a steel wire maintained in vibration electrically to which is attached a small wire dipper making contacts through a cup containing mercury. The interrupted thermopile current is passed through the primary of a small step-up transformer the secondary of which is connected to the grid of the valve.

For quantitative work the thermopile current is balanced by a potentiometer, a minimum of sound in the telephones indicating the point of balance.

The valve has a further advantage over the galvanometer in that it is unaffected by vibration or stray magnetic fields. The use of a valve for such work would seem to have many other applications, and to this end further experiments are being carried out.

L. BELLINGHAM.

71 Hornsey Rise,
London, N.19,
March 22.

The Release of Electrons by X-rays.

IN his interesting article, "Recent Advances in Photographic Theory," in NATURE of March 24, Dr. Mees touches upon the nature of X-rays and the mechanism of their production, and quotes Sir William Bragg's analogy of the plank of wood dropped into the sea.

I believe that Sir William Bragg put forward this analogy in a Robert Boyle Lecture, rather with a view towards successfully visualising the electron-X-ray process than of proving an individual relationship between them. One is tempted to say that an analogy never proves anything, although it may be thoroughly illuminating.

It is an extraordinary fact that a beam of X-rays will release electrons from an object which they hit, with just the velocity of the stream that originates the rays; it appears probable from energy considerations that this relation cannot hold down to the individual electron, so it might not be unprofitable if experiments were directed towards finding the limiting strength of the stream of electrons for the production of X-rays.

S. RUSS.

Physics Department,
The Middlesex Hospital, W.1,
March 26.

The Magnetic Disturbance of March 24–25.

A CONSIDERABLE magnetic disturbance occurred on March 24–25, as recorded by the Stonyhurst magnetographs. There was no marked sudden commencement of the disturbance, but the declination magnet began to move steadily towards the W., accompanied by a decrease in horizontal force, between the hours 8 and 9 G.M.T. The declination magnet attained the extreme limit of its westerly movement at 13 h. 14 m., when it began to move gradually towards the E. At 17 h. 12 m. a period of rapid oscillations commenced on the declination magnet. On the horizontal force magnet the decrease in force was succeeded, at 12 h. 24 m., by an increase. A very rapid oscillation of increase and decrease occurred between 17 h. 2 m. and 17 h. 18 m., the range being 88 γ (1 $\gamma \equiv 10^{-5}$ C.G.S. unit).

A quieter period ensued on the declination magnet between 18 h. 24 m. and 21 h. 12 m., while the horizontal force magnet, after the rapid oscillation at 17 h. 2 m., showed a gradual decrease in force, which reached its limit at 18 h. 48 m. A remarkable rapid oscillation, to E. and return to W., occurred on the declination magnet, between 21 h. 12 m. and 21 h. 26 m., the range of the oscillation being 38′. This was accompanied on the horizontal force magnet by an even more noteworthy rapid oscillation of increase and decrease of force, of range 189 γ, between 21 h. 24 m. and 21 h. 50 m.

The only other notable feature of the disturbance was a bay in both elements, between March 25, 2 h. 12 m., and 3 h. 0 m., the range in declination being 16′, and in horizontal force 97 γ. The more violent phases of the storm had ceased by March 25, 8 h. The extreme ranges were, in declination 1° 6′, and in horizontal force 238 γ. The vertical force magnet showed a general movement, with oscillations, of increase and decrease of force between the hours March 24, 17 h. 12 m., and March 25, 4 h. 24 m. This would indicate the period of the greatest activity of the disturbance. The sensibility of the magnet is uncertain, but the extreme range was about 80 γ.

A disturbed period in magnetic activity occurred on February 25–28, so that this storm follows after an interval of 27 days, the synodical rotation period of the sun. But the solar surface has been unusually quiet during the past two months, at least so far as spots, which have been very few and of small area, and faculæ, which have been very faint, are concerned. The connexion of these disturbances with solar phenomena will require further elucidation. Father Dechevrens, *S.J.*, recorded strong earth-currents at his observatory, St. Louis, Jersey, during the February disturbance. It will be interesting to hear of any observations of aurora borealis.

A. L. CORTIE, *S.J.*

Stonyhurst College Observatory,
April 3.

Pressure of Fluidity of Metals.

MR. HUGH O'NEILL, in his letter in NATURE of March 31, p. 430, gives what he calls H_u, the "ultimate hardness" of tin, zinc, and steel. On referring to my letter at p. 17 of NATURE of January 6, it will be seen that H is there used for H_u, and that the pressure of fluidity = *twice* the ultimate hardness. The units of H_u given at p. 430 are evidently kilograms per sq. mm. Expressing these in kilos per sq. cm. and multiplying by 2 we obtain the following values of the pressures of fluidity as calculated by Mr. O'Neill by means of his equation given at p. 773 of Nature of December 9, 1922.

Metal.	Pressure of Fluidity.
	Kilos per sq. cm.
Tin	1,080
Zinc . . .	5,000
Steel A	19,200
Steel S90 . .	33,600

I have recently (with the generous aid of Mr. R. H. H. Stanger of the Broadway Testing Laboratories, and the following firms who prepared and presented the necessary three specimens of each metal) determined the pressures of fluidity of several metals by direct experiment, so it will be interesting to compare the results, remembering of course that the specimens were *not* made from the same piece of metal as those used by Mr. O'Neill. In the case of my tests the three specimens of each metal were made from the same piece.

The British Aluminium Co. Ltd. supplied the specimens of aluminium.

Messrs. David Colville and Co. Ltd. supplied the specimens of mild steel.

Messrs. Dewrance and Co. supplied the specimens of tin, lead, and zinc.

The Elliott's Metal Co. Ltd. supplied the specimens of copper.

The Muntz's Metal Co. Ltd. supplied the specimens of Muntz's metal.

The experiments were made not merely to determine the pressures of fluidity, but also to test an hypothesis to account for the phenomenon of pressure of fluidity. This hypothesis is far too long to reproduce here, but it will be found in the Transactions of the Society of Engineers for the quarter January-March 1923. It connects the pressure of fluidity with the ultimate shearing and tensile strength of the metal, and was devised in connexion with experiments with clay, and then found to apply to plastic metals as well.

If p be the pressure of fluidity in kilos per sq. cm.,
f be the shearing stress in kilos per sq. cm.,
c be the ultimate tensile strength in kilos per sq. cm.,

then the hypothesis shows rationally on the assumptions made that

$$p = 3{\cdot}68c + 5{\cdot}21f. \quad . \quad . \quad . \quad (1)$$

The pressures of fluidity were determined by means of cylindrical specimens 70 mm. in diameter and 70 mm. high, using a flat-nosed punch 10 mm. in diameter at the end and reduced in the shank to 9 mm. so as to clear the sides of the hole.

Metal.	Tensile Strength c.	Shearing Strength f.	Pressure of Fluidity p.	p' the calculated Value of p.	$\frac{p'-p}{p'} \times 100$.
Lead . . .	114·5	125	777	1,072	+27·5
Lead-tin alloy	244·0	156	1,233	1,706	+27·7
Tin . . .	223	232	1,367	2,025	+32·5
Aluminium .	827	577	4,015	6,045	+33·6
Copper . .	2192	1445	10,860	15,590	+30·1
Muntz's metal	3686	2004	(16,800)*	23,966	
Mild steel .	4380	2990	(22,140)*	31,625	Mean +30·3
Zinc . . .	214	755	[7,760]	4,707	..

All stresses are in kilograms per sq. cm.

* These are *not* experimental values, but merely predictions.

The relation given by equation (1) thus on the average gives results which need reducing by 30 per cent. to arrive at the actual values, and the maximum departure from this mean is 3·3 (aluminium).

Zinc is a rank outsider as regards this hypothesis! But zinc has no plasticity. It did not elongate or show any contraction of area under a tensile force. In shear even it failed by tension, and when the pressure of fluidity experiment was made, the specimen gradually burst by yielding in tension on several vertical planes.

With regard to the variation of the figures in the last column, it must be remembered that these depend on the experimental values of f and c, which themselves vary. For example, in the case of the shearing tests, two experiments were made with each metal, the planes of shear being about one inch apart on the same specimen. For all this the values of f differed by 4·3 per cent. and 5·5 per cent. in the cases of tin and aluminium respectively.

A. S. E. Ackermann.

17 Victoria Street, Westminster, S.W.1,
March 31.

Use of the Millibar in Aerodynamics.

The millibar, introduced by Sir Napier Shaw into British meteorology, brings the same drastic simplification into the numerical relations between pressure and velocity in aeronautics.

The accompanying diagram (Fig. 1) shows the

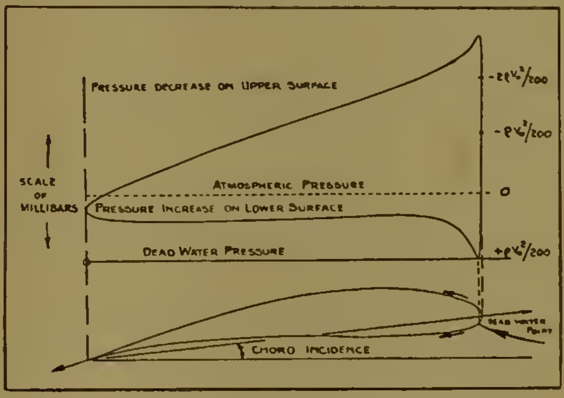

Fig. 1.

pressure distribution round a wing profile, calculated in accordance with Joukowsky's theory.

In C.G.S. units $p - p_0 = \frac{1}{2}\rho\,.\,(v_0^2 - v^2)$ dynes/cm.^{2} or microbars, where p, v are the variable pressure and velocity at points on the profile, p_0, v_0 the values at a distance, and ρ the density of the air.

Expressing ρ and v in M., Kg., S. units, which are more convenient for aeronautical measurements,

$$\begin{aligned} \text{pressure} &= \tfrac{1}{2}\rho\,.\,(v_0^2 - v^2) \text{ m.kg.s.}^{-2}\text{m.}^{-2} \\ &= \tfrac{1}{2}\rho\,.\,(v_0^2\,.\,10^{-2} - v^2\,.\,10^{-2})\text{mb.} \\ &= \tfrac{1}{2}\rho\,.\,10\,.\,(v_0^2\,.\,10^{-2} - v^2\,.\,10^{-2}) \text{ megadynes/m.}^2. \end{aligned}$$

The last two forms lend themselves to computation, since flying speeds usually lie between 10 m./s. and 100 m./s. The absence of all extraneous factors save integral powers of ten is sufficient proof of the practicality of Sir Napier Shaw's action.

In the minority of cases where the forces considered are produced by the action of gravity on known masses, they are easily transformed, for the megadyne is $10/9{\cdot}81 = 1{\cdot}02$ kgm. weight, and the millibar is $1000/981 = 1{\cdot}02$ cm. head of water with an accuracy amply sufficient for aeronautical measurements.

A. R. Low.

London, March 22.

The Sun-Cult in Ancient Egypt.[1]

By Aylward M. Blackman, D.Litt.

II.

It has often been maintained that the Aton-cult instituted by Ōkhnatōn (Amenōphis IV.) displays non-Egyptian features and is in a large measure the product of foreign influences. I hope, however, clearly to show here that in the main it is the outcome of certain tendencies of the old solar religion discussed in the previous article — tendencies which had begun to manifest themselves so far back as the Old Kingdom, which came increasingly into evidence during the Middle Kingdom and the eighteenth dynasty, and finally found in the teaching of King Ōkhnatōn a somewhat particularised expression.

It was pointed out in the first article that the sun-god, owing to the political and religious importance of Heliopolis, became at a very early date the State-god of Egypt, and that the priests of a number of the local gods, in order to enhance their prestige, identified them with the sun-god, the goddesses who were associated with these gods being identified with Ḥatḥor, the sun-god's consort. There was also, it must be noted, a distinct tendency to identify the various divinities with one another, thus considerably reducing their number as separate entities in the Pantheon. All this, combined with the prevailing uniformity in the structure and equipment of the temples, the temple liturgy, and the organisation of the priesthood—a uniformity due to the predominant influence of Heliopolis—fostered the growth of monotheistic or, anyhow, henotheistic ideas.

During the Middle Kingdom, when a Theban line of kings ruled over a united Egypt, Amūn, the local god of Thebes, was identified with the sun-god, being henceforth known as Amunrēʿ. As a result of the imperial expansion of Egypt under the Theban emperors of the eighteenth dynasty, the sun-god, originally the national god of Egypt and the prototype of the Egyptian Pharaoh, became in the person of Amunrēʿ a world-god and a world-ruler. Thus the victorious Tethmōsis III. says of Amunrēʿ that "he seeth the *whole world* hourly." A hymn in praise of the sun-god, written in the reign of Amenōphis III., the father of Ōkhnatōn, speaks of the sun-god as "the sole lord taking captive all lands every day, as one beholding them that walk therein." The once merely national god has thus become a deity who exercises universal sway and possesses universal vision.

But the god of this hymn is not only the all-powerful, all-seeing ruler: he is also the beneficent protector and sustainer of mankind—"the valiant herdsman who drives his cattle, their refuge and the giver of their sustenance." It will be remembered, of course, that the sun-god appeared already in the literature of the seventh to eighth dynasties in the guise of "the shepherd (or herdsman) of all men." This same hymn further emphasises the sun-god's beneficent nature in calling him "a mother, profitable to gods and men." As is so frequently maintained in the religious literature of the Imperial Age, this hymn also asserts that the sun-god is the source of all, including his own, being. "Thou art the craftsman shaping thine own limbs; fashioner without being fashioned."

From this and other compositions it can be seen that the religious thought of the period just preceding the reign of Ōkhnatōn was distinctly monotheistic in its tendency. It was only necessary to advance this tendency a step or two further to arrive at actual monotheism. This is what Ōkhnatōn did when he asserted definitely once and for all that the sun-god was not only the supreme and universal god, but also the only God—an assertion that had never been definitely enunciated by the theologians who had preceded him, but had only been sporadically and somewhat vaguely hinted at by them.

The universality of Ōkhnatōn's god is clearly set forth in the famous hymn, which so closely resembles the 104th Psalm, and of which the king claims, probably with right, to be the author. The sun-god is represented as the All-Father, the source of all life. He it is who has created the different nations and assigned them their divers complexions and languages. He has also provided for their sustenance, making the Nile to well up out of the nether world to water the land of Egypt, but setting a Nile in the sky for other peoples, whence it comes down as rain. "Thou didst make the distant sky in order to rise therein, in order to behold all that thou hast made. . . . All men see thee before them, for thou art Aton of the day aloft."

There has been a certain amount of controversy as to whether Ōkhnatōn was actually himself responsible for the establishment of this monotheistic sun-cult. As has been stated at the beginning of this paper, some scholars incline to the view that the Aton-cult is distinctly of foreign origin and that its being established as the State-religion was due to the influence of Tyi, herself a foreigner, by whom her son Ōkhnatōn was completely dominated. Others, again, have maintained that the establishment of this cult was due to the successful intrigues of the Heliopolitan priests, who, attaining the ascendancy over a weak king, temporarily regained the religious hegemony of Egypt.

Those who take the view that the religious revolution was the work of Tyi and foreign influences, or of an intriguing priesthood, find the main support for their respective theories in the fact that the body, supposed to be that of Ōkhnatōn, is that of a man who could not have been more than 25 to 26 years old when he died, while the skull shows distinct signs of hydrocephaly, indicating that the person in question was weak intellectually. As Ōkhnatōn is known to have reigned for more than sixteen full years, he can, if this is his body, have been only ten or eleven years old when he came to the throne and the religious revolution began, and only sixteen or seventeen when he definitely broke with the priests of Amūn, changed his name from Amenḥotpe to Ōkhnatōn, and deserted Thebes and founded his new capital at El-Amarna. Yet before this change in name and residence two of his daughters, as a relief distinctly shows, were old enough to accompany him when he officiated at the temple liturgy, and, moreover, before the aforesaid change

[1] Continued from p. 502.

took place, *i.e.* before the sixth year of his reign, we happen to know that Ōkhnatōn celebrated the so-called *sed*-festival, a festival marking the 30th anniversary of the Pharaoh having been designated heir to the throne. Had it not been for the age-limit imposed by Okhnatōn's supposed body, we should naturally have imagined, in view of this last piece of evidence, that when he succeeded his father, Amenōphis III., he must have been at least 24 or 25 years old.

As a matter of fact, however, though the coffin in which the body was found was beyond question made for Ōkhnatōn, yet the body itself is almost certainly not his, the date of the objects found thereon, as Prof. Sethe has recently shown, precluding that possibility.

There can be little doubt, therefore, that Ōkhnatōn was a full-grown man when he came to the throne, while at the time of his break with the priests of Amūn and his shifting of the capital to Middle Egypt he was more than 30 years old, and accordingly at the height of his intellectual and physical vigour. The fact that Ōkhnatōn's supposed body is not his at all also disposes of the theory that he was weak mentally. There is, therefore, no necessity whatever to suppose that the new faith, which contemporary records so closely associate with the person of the king and which he was certainly quite old enough to have formulated, was the product of foreign influences during a regency of Tyi, nor yet of the Heliopolitan priesthood struggling for a religious and political supremacy. That Ōkhnatōn really was a man of exceptional mental gifts and high ideals—Breasted calls him "the first individual in history"—is evident from that remarkable portrait of him found at El-Amarna in 1912 and now in the Berlin Museum. All who see it are impressed by the beauty of the features and expression, the thoughtfulness pervading the whole countenance.

We need not, however, go to the other extreme, as some writers have done, and regard the love of righteousness and the beneficence attributed to Ōkhnatōn's god as primarily the expression of the king's own ideas and feelings. On the contrary, as has been pointed out in the preliminary article, these are the very qualities assigned to the old Heliopolitan sun-god. How far, indeed, the old solar religion had advanced in these particular directions, even before the Middle Kingdom, is especially evident in a literary composition of the ninth to tenth dynasties, to which by an oversight no reference was made in the above-mentioned article. In one portion of the work in question the ancient writer speaks of men as "the flocks of God (*i.e.* the sun-god)." God, he goes on to say, "made heaven and earth at their (*i.e.* men's) desire. He checked the greed of the waters, and made the air to give life to their nostrils. They (men) are His own images proceeding from His flesh. He arises in heaven at their desire. He sails by (*i.e.* in the celestial solar barque) in order to see them. . . . When they weep He heareth. . . . How hath He slain the froward of heart? Even as a man smiteth his son for his brother's sake. For God knows every name."[2] In the preceding section of the same work we read that "more acceptable (to the sun-god) is one righteous of heart than the ox of him who doeth iniquity."

[2] A. H. Gardiner, "New Literary Works from Ancient Egypt," in *Journal of Egyptian Archæology*, vol. i. p. 34.

That Ōkhnatōn's sun-cult is nothing more than a special development of the older sun-cult becomes only more evident the further one pursues one's researches. In the earliest stage of the cult the god appears simply in the guise of the Heliopolitan sun-god, Rēʿ-Horus of the Two Horizons (Rēʿ-Harakhte), with whom indeed, as we shall see, he was actually identified. As such he is depicted as a human figure with a hawk's head surmounted by the uræus-encircled sun's disk. Later on, however, but before the migration of the court to El-Amarna, the mode of representing the god was entirely changed. He was depicted as a solar disk, from which descend rays terminating each in a human hand—these hands being the only trace left of the old anthropomorphism, if they are not, as is quite likely, simply an expression of poetic fancy. The uræus was also retained, sometimes hanging from the disk, generally, however, rising up from the bottom edge towards the centre, though it was of no religious significance, but merely the emblem of kingship—Ōkhnatōn's deity being not only the world-god but the world-king.

The name of the new god in ordinary everyday parlance was *pa Aton*, "the Aton," aton (*itn*) being the word used then and earlier to denote the visible, physical solar body, though, as Sethe points out, the word seems occasionally to have been employed, even before Ōkhnatōn's time, to designate the sun-god himself. Generally, however, it just denotes the sun as a natural phenomenon or cosmic body, as distinguished from the god dwelling in it, a sense in which the word Rēʿ is never used.

According to the old theological teaching the physical sun was simply the embodiment of the god. Thus we read of "Atum (the sun-god) who is in his *aton*," "Rēʿ whose body is the *aton*," and him "who lightens the Two Lands (Egypt) with his *aton*." In fact, it was exactly on account of the very definite meaning of the word *aton*, Sethe maintains, that Ōkhnatōn chose it as the designation of his god; for the new religion was entirely materialistic in its conception of the Supreme Deity, in marked contrast to the—it must be confessed—much more spiritual conception of the old religion. Indeed it is just here that Breasted has gone astray when he asserts that "it is evident that the king was deifying the force by which the sun made itself felt on earth,"[3] an assertion that is based on a mistranslation of the Aton's official nomenclature (see below). On the contrary, it was the actual cosmic body, the physical sun itself, not a mysterious power incorporated in it or working through it, which Ōkhnatōn made his subjects worship.

In addition to the ordinary name, the Aton, the god also bore an official or formal designation, the words composing it constituting a short profession of faith—a compressed creed. This designation, which, on account of the god's world-wide kingship, was, like the two names borne by every Pharaoh, enclosed in two cartouches, appears in two forms, an earlier and a later. The earlier, which dates from the very commencement of the reform, and continued in use until after the seat of government had been moved from Thebes to El-Amarna, is as follows:—"Liveth Rēʿ-

[3] Breasted, "Development of Religion and Thought in Ancient Egypt," p. 321.

Horus of the Two Horizons, rejoicing in the horizon, in his name Shu who is Aton." The new god is thus identified with the two forms under which the sun-god was known both before and after the reign of Ōkhnatōn—Harakhte (= Horus of the Two Horizons) and Shu. The epithet "rejoicing in the horizon" is not, Sethe points out, an invention of Ōkhnatōn's, but appears earlier in the eighteenth dynasty as a description of the sun-god. Shu, originally personified space, was, as Sethe also points out, a common appellation of the sun-god from the Hyksos period onwards, and never (certainly not as written in this cartouche with the sun-determinative) can be used in the sense of "heat" or "splendour," as Breasted and Erman respectively have supposed. Sethe rightly maintains that the prominent feature in this official nomenclature is the element Rēʿ-Harakhte, the name of the Heliopolitan sun-god, all the rest, even the name Aton, being purely subsidiary.

The later official designation, which came into force apparently soon after the eighth year of the king's reign, is marked by certain significant changes. It runs as follows:—"Liveth Rēʿ, the ruler of the Two Horizons, who rejoices in the horizon, in his name Father of Rēʿ, who has come as Aton."

It will be seen that Horus and Shu, names which Ōkhnatōn perhaps thought were too definitely associated with the old religion, have been struck out and replaced by two epithets, "Ruler of the Two Horizons" and "Father of Rēʿ." The name Rēʿ, which has not been interfered with, had been, as Sethe points out, a regular element in the Pharaoh's first cartouche ever since the fifth dynasty, and as such was of no theological significance. Also the king evidently had no objection to this old name of the sun-god. For example, he still retained the royal title Son of Rēʿ; Rēʿ appears as an element in his own first name and in the names of his two daughters; two temples or shrines associated with his mother Tyi and his daughter Meritaton bore the name "Shade of Rēʿ"; and the king himself, like other Pharaohs, is officially spoken of as Rēʿ.

The element "Father of Rēʿ" in the god's official designation is interesting, taking as it does the place of Shu. Shu, according to the old Heliopolitan theology, was the son of Rēʿ, and as such he actually was assigned that title. It would, Sethe suggests, have been scarcely tolerable to the founder of the new religion that Aton, the creator and author of all being, should be regarded as the son of Rēʿ, the sun-god of the old religion. Ōkhnatōn therefore asserts that his god is the father of Rēʿ, *i.e.* he makes him cosmically older. The fact that the god is called Rēʿ, and, at the same time, the Father of Rēʿ, reminds one of the old epithet of Amūn, Bull of his Mother, which simply means that he is self-created, that is, that he was not begotten by another. Sethe rightly maintains that though this epithet has a polytheistic touch about it, Ōkhnatōn would have been as little conscious of this as were the Christian Fathers when they formulated the doctrine of the Blessed Trinity.

Sethe directs attention to another very interesting point in this later designation of the god. "To come," he says, "has obviously here, as so often, the meaning of 'to come again.' The Father of Rēʿ in question is thought to have come again after he had obviously disappeared or had been mistaken for another through man's ignorance, and indeed he has come again in the form of the apparently new but in reality primæval god of Amenōphis IV."

Let us now consider briefly the temples of the Aton erected at El-Amarna and the liturgy celebrated therein. The main difference between the temples of the Aton and those of the old Solarised religion lies in the fact that the former seem to have been roofless. There were thus no columned halls and dark, mysterious sanctuaries with their surrounding chambers, the place of these being taken by a series of main and subsidiary courts lying behind the forecourt and leading one out of another. The reason for this architectural change was that Ōkhnatōn permitted no cultus-image of his god to be made, not because he was an iconoclast or afraid of idolatry, but because his conception of God was so intensely materialistic. The Aton, as already pointed out, was the actual physical sun, the cosmic body itself, not a divinity dwelling in that body and manifesting himself through it, and therefore ready similarly to manifest himself through a cultus-image, which was "the body" of the divinity it represented, according to the ideas of the ancient theologians—as we should express it, the divinity's embodiment. Offerings had, therefore, to be made direct to the god in the sky, a procedure which necessitated a roofless temple, for no roof must intervene between the god and the offerings held up to him and laid on the altar.

Despite this complete break with the old conception of the indwelling presence of the god in the temple-sanctuary,—a conception which brought the god so near to his priests and worshippers—it is remarkable how closely in many respects the general plan and equipment of the traditional Egyptian temple were adhered to, a clear indication that there were no direct foreign influences at work in the new religion; indeed, the architecture down to the very last detail is purely Egyptian. We still find the pylon with its two beflagged towers and the great forecourt with its large stone altar in the midst[4]—the forecourt being colonnaded in the case of the temple bearing the name of "Shade of Rēʿ of the Queen Mother, the Great Royal Wife, Tyi." Evidently, too, the rearmost court of all in the Aton-temples, which occupied the place of the sanctuary in the ordinary Egyptian temple, was regarded as particularly sacred. Again statues of the king and also of the queen were set up as heretofore in different parts of the temples, the king and queen being thus enabled, so it was thought, to function perpetually as worshippers and offerers, or conversely as the recipients of worship and offerings. Yet again, before the entrance to what N. de G. Davies calls "the inner temple" of the Aton stood eight tanks of water for the purification of those who entered it. Such tanks or pools of water were, as pointed out in the preliminary article, a characteristic feature of the old Heliopolitan sun-cult. Finally, the "inner temple" was called the House of the Benben, the *benben* being, as we have seen, the sacred pyramidion in the great sun-temple at Heliopolis. Curiously enough, in the representations we possess of Ōkhnatōn's Aton-temples,

[4] By an oversight no reference was made in the account of an ordinary Egyptian temple, given in the preliminary article, to the stone altar that always stood in the colonnaded forecourt.

no obelisks (which were so closely associated with the old sun-cult) are depicted as standing before the main entrance or elsewhere in the sacred precincts. However, we know that Ōkhnatōn erected an obelisk in honour of Harakhte-Aton at Karnak, probably in connexion with his *sed*-festival celebrations.[5]

The Aton-temple liturgy itself is clearly the old temple liturgy adapted to the new ideas and new requirements. As there was no cultus-image, there was no place in the new worship for the toilet, or indeed many of the pre-toilet, episodes of the old liturgy. The worship of the Aton seems to have consisted mainly in the presentation to the god of food- and drink-offerings, perfumes, and flowers, and in the chanting of hymns and in musical performances in general. But the ceremonies connected with the presentation of offerings were those of the old religion, the officiant consecrating the offerings in the time-honoured fashion, *i.e.* by extending over them the so-called *kherp*-baton. As in the old liturgy, this ritual act was preceded by the burning of incense and the pouring out of a libation of water; indeed, the burning of incense and the pouring out of a libation were, as in times past, the regular accompaniments of every act of offering. The liturgy was celebrated, as of old, to the accompaniment of the rattling of sistra, and also of other musical performances, vocal and instrumental. Lastly, it should be pointed out, the ceremony of sweeping the floor—the removal of the foot-prints—before and after the celebration of the liturgy seems almost certainly to have been retained.

This article cannot be satisfactorily concluded without a brief discussion of two important questions that have already been touched upon in the preceding paragraphs, namely, Ōkhnatōn's quarrel with the priests of Amūn, and the theory advanced by some scholars that in the establishment of the Aton-cult we are to recognise a temporary restoration of the political and religious supremacy of the Heliopolitan priesthood.

Long before the time of Ōkhnatōn the Theban god Amūn had been completely identified with the Heliopolitan sun-god. What, then, was the cause of the king's rupture with the priests of Amūn and his breaking away from all Theban influences?

It must be borne in mind that the monotheistic tendencies of the preceding period had in no way affected the customary performances of the old institutional religion. Whatever may have been the speculations and ideas of the learned and enlightened few, the worship of the gods was conducted in exactly the same way as it had been for centuries, without a single hint at a change in the traditional ceremonial. Ōkhnatōn's religious revolution, on the other hand, not only entailed a great change in the conduct of the temple services and far-reaching structural alterations in the temple buildings, but also, since the king would brook no rival to his god, the suppression of all the festivals and other performances connected with the provincial cults and with the various cults established at the capital. All this was a completely new attitude in Egyptian religious experience; indeed we are encountering the "jealous God" for the first time in human history, several centuries before His appearance among the Hebrews. The feelings both of the priests and of the masses of the people must have been deeply stirred by this attack on their religious observances, particularly in so far as it affected the festivals celebrated in honour of the local divinities, festivals which no doubt played as great a part in the lives of the people as do those celebrated in honour of the local Egyptian saints at the present day.[6] In fact, there can be no question that Ōkhnatōn's reform meant far too sharp a break with the past for his intensely conservative-minded subjects.

It should here be pointed out that so early as the reign of Tethmōsis III. all the priesthoods of Egypt had been combined in one great organisation, with the high-priest of Amūn at their head. To the high-priest of Amūn, therefore, and to the priesthood of Amūn as a whole, all the local priesthoods would have looked to champion their threatened rights, while in Ōkhnatōn's eyes this very high-priest and priesthood would have appeared as the embodiment of all the forces of reaction against which he was struggling. Herein lay quite sufficient cause for his breaking away entirely from Thebes and the Theban god. We must also remember that Ōkhnatōn's materialistic conception of the Aton was entirely opposed to the—as already pointed out—much more spiritual conception of the sun-god formulated by the theologians of the old religion. It was impossible to regard the actual corporeal and localised divinity, such as Ōkhnatōn maintained his sun-god to be, as capable of identification with a being (or beings) who could manifest himself (or themselves) in all manner of forms and in many places. Did the cause of the final rupture reside in this difference of conception as to the nature of the Godhead? If so, we have here a foretaste of those great theological controversies which troubled the Christian Church of the first five centuries, and of the seventeenth-century wars of religion.

Let us now briefly consider the theory that in the institution of the Aton-cult we are to recognise the restoration of the political and religious supremacy of Heliopolis. In view of all that has been set forth in the preceding paragraphs, the Heliopolitan sun-cult is clearly to be regarded as the basis of the new religion, or rather as supplying all the material out of which the new edifice was constructed. On the other hand, the particular shape that that edifice assumed must be regarded as the work of Ōkhnatōn. If the sun-cult had been officially promulgated by the organised priesthood of Heliopolis or, as Borchardt[7] suggests, of Hermonthis (Heliopolis of Upper Egypt [*Iwnw šmʿ*]), Ōkhnatōn, instead of founding an entirely new capital at El-Amarna, would have been obliged to install the seat of government in or very near the actual official centre of the religion he had adopted. But he was able to act as he did, because the religion he professed was regarded as a completely new religion, a special revelation to himself, as he distinctly asserts. It was therefore not associated with any particular locality, so he was free to make his capital in any place that seemed to him to be most free from the old traditions and best adapted to his requirements.

Lastly, just a few words on the frequently-made assertion that foreign influences are discernible in the

[5] Schäfer in *Amtliche Berichte aus den preuszisch. Kunstsammlungen*, xl. 10, col. 227.

[6] See W. S. Blackman, "Festivals celebrating Local Saints in Modern Egypt," in *Discovery*, vol. iv. No. 37, pp. 11-14.

[7] *Mitteilungen der Deutschen Orient-Gesellschaft zu Berlin*, March 1917, No. 57, p. 27.

Aton-cult. That there are no traces whatever of such influences, but that the Aton-cult is in every respect essentially Egyptian, the facts set forth in this article must have made perfectly clear. However, it is possible that Ōkhnatōn had foreign blood in his veins, for Prof. Elliot Smith maintains that his maternal grandfather, Iuyu, is distinctly non-Egyptian in type. To this dash of foreign blood, therefore, may well be due the originality clearly displayed by Ōkhnatōn in the particular expression which he gave to a certain trend of religious thought prevailing among his contemporaries.

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Scientific Investigation of the Whaling Problem.

By Sir Sidney F. Harmer, K.B.E., F.R.S.

The Colonial Office has recently announced that the *Discovery* has been purchased by the Crown Agents for the Colonies, on behalf of the Falkland Islands, for employment in researches, principally on whaling, off South Georgia and the South Shetlands. The *Discovery* was built for Capt. R. F. Scott's first Antarctic Expedition (1901–1904). She is a strong wooden vessel of about 700 tons register, and she has been chosen with special reference to her suitability for ice-work.

Subantarctic whaling commenced at the end of 1904, at a time when the industry was regarded as almost obsolete, owing to the exhaustion of the old whaling fields. It increased with so much rapidity that more than 10,000 whales were caught during the season 1911–12. At first concerned almost exclusively with the humpback, the operations are at present supported almost entirely at the expense of the much larger fin whale and blue whale. Humpbacks showed an alarming decline in numbers after the 1911–12 season, though they have made some recovery during the last two whaling seasons.

It should be realised that modern whaling is carried on by comparatively small steam vessels fitted with appliances for the capture of the whales, the products of which are worked up by factories on shore or by larger steamers, the floating factories. In either case, suitable harbours are required as bases, and the most favourable localities at present known are South Georgia, which lies to the east of the Falkland Islands, and the South Shetlands, which are farther to the south-west. These islands are dependencies of the Falkland Islands, and are accordingly under British jurisdiction.

As the result of several memoranda which were prepared in 1917 by Mr. E. R. Darnley, of the Colonial Office, an Interdepartmental Committee on research and development in the dependencies of the Falkland Islands was appointed by the Secretary of State for the Colonies in 1918; and its report (Cmd. 657) was published in 1920. The report contained a number of recommendations with regard to the investigations which were required; and the purchase of the *Discovery* is the first practical result of these suggestions. It should be mentioned that an earlier Anglo-Swedish scheme for the investigation of the same problems was abandoned on the outbreak of war in 1914.

The object of the projected voyages is to obtain scientific evidence bearing on the whaling problem generally, with the view of ascertaining to what extent protective measures are required. It has to be determined, in the first instance, what are the species of whales which are being hunted. Although known to the whalers as humpback, fin whale, and blue whale, it is uncertain whether these are identical with the northern whales known by the same names. Whales are migratory animals, and there can be no reasonable doubt that they visit the Antarctic Ocean in order to profit by the rich food-supply of its waters, and that they afterwards depart, fatter than when they arrived, to warmer waters, which are probably visited for breeding purposes. More definite information is required with regard to these migrations, and it is hoped that it may be possible to obtain direct evidence by a system of marking individual whales.

The period of gestation, the seasons when pairing and birth take place, and the rate of growth after birth all need further study. The plankton requires investigation, in view of the dependence of the whales on it for food; while the temperature of the water, with other hydrographical questions, has to be studied, in order to ascertain how far these factors influence the movements of whales. There is already some reason to suppose that the position of the northern edge of the Antarctic ice is a factor which is correlated with the success or failure of a season's working. If the summer is relatively warm the ice will be too far to the south and the whales will probably be too distant from the base. If the summer is cold the whales will be too much to the north. It may be anticipated that there is an optimum position for the ice which brings the main stream of whales to the neighbourhood of the whaling stations.

Although whalebone whales all feed on plankton, individual species are known to have a preference for one kind of plankton rather than another. In most localities the humpback consumes a considerable amount of fish, while the blue whale is said to feed exclusively on Crustacea. The distribution and the seasonal occurrence of various kinds of plankton, and the examination of the stomach-contents of whales, are matters with which the expedition will certainly have to deal; and the results may prove to have a distinct bearing on the question why each species of whale differs from the others in its seasonal occurrence. The abundance of whale-food is dependent on conditions favourable for the growth of diatoms and other chlorophyll-containing organisms; and in this connexion may be mentioned Mr. A. G. Bennett's interesting observation that the skin of certain whales is covered by a film composed of innumerable diatoms. The evidence is in favour of the view that this skin-film is not present on thin individuals which have recently come down from the north, but that it develops during the stay of the whales in Antarctic waters. The study of the film and perhaps of whale-parasites may prove to be capable of giving important information with regard to migrations.

For many years the Norwegians have taken the leading place in the whaling industry, and they have large interests in Antarctic whaling. It is thus natural that they should feel anxiety with regard to the possible results of a protective policy, and this is shown by an article recently published in the *Anglo-Norwegian Trade Journal* (Vol. 9, No. 98, February). The comments in question were a rejoinder to criticisms of the whaling industry which had appeared in the *Morning Post*, based on a lecture given by myself, as reported in NATURE (Vol. 110, December 16, 1922, p. 827). I had pointed out, on the incontrovertible evidence of history, that the operations of whalers in the past have been invariably followed by a depletion of the whaling fields. The Atlantic right whale no longer frequents the Bay of Biscay in numbers sufficient to maintain a whaling industry, nor is the Greenland whale still common in the bays of Spitsbergen, in Davis Straits, or even in the North Pacific. The grey whale disappeared long ago from the lagoons of California, and there is no longer occupation for the hundreds of vessels which left European and American ports annually, in the eighteenth and part of the nineteenth centuries, in pursuit of the Greenland and other right whales and the sperm whale. With these facts in view the least that is required is the adoption of a cautious policy, lest the mistakes of the past should be repeated.

The whaling companies are admittedly interested in the avoidance of extermination, which would mean the closing of their operations, but their advocates have maintained that, in view of the enormous extent of the oceans which are frequented by whales, the activity of hunters in a small area is not likely to produce much effect in reducing their number. It will be seen, however, by consulting a map, that South Georgia and the South Shetlands lie in the region where the Antarctic Ocean is narrowest, and that they are admirably situated to intercept the stream of whales in their circumpolar movements. It would not be surprising if operations at these stations alone were found capable of depleting very seriously the entire stock of Antarctic whales, even if no new stations were to be founded in other localities, as seems likely to happen in Ross Sea, for example. The danger is all the greater, taking into consideration the highly efficient methods of modern whaling.

The acquisition of a sound body of scientific evidence is the object of the expeditions which are being planned by the Colonial Office. Although I do not conceal my personal conviction, as at present informed, that whaling is being conducted on too large a scale, I do not deny that a study of the subject by competent investigators on the spot may lead to a different conclusion. The Trustees of the British Museum have acted in an advisory capacity to the Colonial Office since they first became interested in Antarctic whaling, not long after its inception. I am authorised to state that they do not desire to take up an extreme position in the matter, but that their efforts are directed to the restriction of whaling to an extent which is not inconsistent with the permanent preservation of whales. This is a moderate view, with which it may be hoped that the representatives of the whaling industry will agree in principle. The article to which I have referred virtually admits as much, and the willing co-operation of the whaling companies will be of the greatest value to the expedition. It may be hoped that it will be possible to find a *modus vivendi* satisfactory to both parties, who are equally interested in preventing the extermination of whales.

Einstein and the Recent Eclipse.

THE results of the expeditions from Canada and the Lick Observatory to Wallal, Western Australia, for the solar eclipse of last September have now come to hand; and both report in favour of the Einstein shift of starlight. In each case the number of stars measured was very large—exceeding eighty—the magnitudes being between the seventh and the tenth. From this it is evident that the exposures were comparatively long, and consequently there would be considerable extension of the corona on the plates, which would obliterate the stars nearest the sun. The measures, however, were sufficiently exact to give a decisive result using the more distant stars. Profs. Campbell and Trumpler measured all their plates in duplicate; the values for the shift at the limb of the sun deduced from the individual plates ranged from $1{\cdot}59''$ to $1{\cdot}86''$, the mean of all being $1{\cdot}74''$, which is only $0{\cdot}01''$ less than Einstein's predicted value.

As Prof. Campbell is well known to have been in no sense predisposed in favour of Einstein's theory, this result, combined with that of Prof. Chant and the mean of the Principe and Sobral results in the 1919 eclipse, will probably be regarded as setting the question at rest. Prof. Campbell says in his telegram that he considers further work of this kind unnecessary, so that he will attack other problems in the Californian eclipse of next September. There are still the plates taken by the Australian expeditions to be measured. This is to be done at Greenwich; their scale is smaller than that of the Lick Observatory plates, so that probably less weight will attach to them.

The evidence as regards the presence of the shift in the solar spectral lines is now fairly evenly balanced "For" and "Against"; but in any case this test is a less decisive one than the other two, since there are so many known causes of shift of spectral lines, which it is not easy to eliminate completely.

A. C. D. C.

Current Topics and Events.

THE agricultural Tribunal of Investigation appointed by the Government to inquire into the present position of the farming industry and to suggest methods for its improvement has issued an interim report. Its recommendations are being actively discussed in the daily press, mainly from the political aspect. At present the majority of farmers are undoubtedly in an unsound economic condition, and especial interest therefore centres in these sections of the report dealing with agricultural organisation and education. The Tribunal is impressed by the extent of co-operative measures both in Europe and in America, and in urging that British farmers should form similar organisations, suggests that the study of the economic organisation of the industry should have fuller recognition in the farm institutes and agricultural colleges. The Tribunal pays a tribute to the work carried out by the research staffs of these institutions and considers that the departments dealing with the economic problem should be further developed. New systems of farm management, in particular the maintenance of livestock on arable land,—the soiling system,—are suggested as urgent problems to be investigated from this point of view. It is pointed out that in the United States 50 per cent. of the research grants are devoted to farm economics as against 10 per cent. in this country. In this connexion, however, it should be remembered that the term "farm economics" has a much wider interpretation in America than would be admitted here, due in part to the absence, until recently, of the settled rural population that marks the older countries. Making due allowance, however, for this and for the characteristic American tendency towards over-organisation, the comment of the Tribunal still remains true in substance. It is to be hoped that this essential bridge between the research workers and the farmers will be strengthened as a result of the Tribunal's recommendations.

THE Secretary of State for the Colonies has appointed an executive committee to control the researches recommended by the Inter-Departmental Committee on Research and Development in the Dependencies of the Falkland Islands, and in particular the investigation of the question of the preservation of whales and of the whaling industry, which has been subject to Government regulation since its inception nearly twenty years ago. The members of the committee are as follows:—Mr. Rowland Darnley (chairman), Colonial Office; Sir Sidney Harmer (vice-chairman), British Museum (Natural History); Mr. H. T. Allen, Colonial Office; Mr. J. O. Borley, Ministry of Agriculture and Fisheries; Capt. R. W. Glennie, R.N., Admiralty; Mr. J. M. Wordie, Royal Geographical Society: and Sir Fortescue Flannery, of Messrs. Flannery, Baggallay and Johnson, consulting naval architects to the Crown Agents for the Colonies, who has consented to serve as a member of the committee until the *Discovery*, which has been purchased for the purposes of the research expedition, has been reconditioned. In another part of this issue, Sir Sidney Harmer gives some account of the scientific results to be expected from the cruises which it is anticipated the *Discovery* will undertake.

THE report of the nineteenth year's work of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington has lately been issued in the Year Book of the Institution for 1922. The non-magnetic ship *Carnegie*, after twelve years' voyages which have been of great import to the science, is now out of commission for a time, while the observing staff is largely occupied with re-observations in land areas where further information, chiefly to determine the secular variation, was needed. An analysis of the vast body of data acquired by the Department is now in progress. Two magnetic observatories have been set up, in Western Australia and in Peru, regions of the globe where such institutions are much needed, and help has been given in carrying on the former German observatory at Apia, in Samoa. The Department has now turned its energies to the much-neglected study of earth-currents, and is devising new methods of registration. Dr. S. J. Barnett, chief of the section of experimental work in pure magnetism, is vigorously prosecuting his researches on magnetism by rotation, and the converse effect. The investigation of atmospheric electricity is also being extended. A conference of American men of science was held at the Department during the year, in order to consider what modifications, if any, of the original programme of the Department should now be made, and the conclusions and recommendations of the conference are being taken as a guide in the further development of the activities of the Department.

IN the "Shirley Institute Memoirs," vol. 1, 1922, recently received, are collected the ten papers published during the year by the British Cotton Industry Research Association. A perusal of this volume affords an encouraging picture of the future of textile research in this country if the high standard indicated is maintained. The work described falls naturally into three well-defined sections—chemical and physical, biological, and technological. Four papers are résumés of the literature of some chemical, physical, and botanical aspects of cotton, and should be of much value to workers in this field, in which the literature is scattered and much of it almost inaccessible: more than 380 references are given. The biological papers have been dealt with previously in these columns and need no further mention. The three most striking papers are the technological contributions dealing with some properties of yarns, such as regularity in relation to tensile strength and twist. They materially increase our somewhat scanty knowledge of the nature of yarns, and the original methods of investigation described are of wide application. Until the present publication little of permanent value has been done on yarn structure since the pioneer work of

Oliver in 1905–7 (Proc. Roy. Soc. Edin.). A large field of work of extreme difficulty and fascination is here awaiting attack by the physicist and the mathematician, and not the least important of the functions of textile research associations lies in removing such problems from the almost complete obscurity and isolation they have hitherto "enjoyed." It is almost unknown outside the industry that many of the most fundamental problems in textile technology are problems for the mathematician and the mathematical physicist, and there is little doubt that in a few years' time a real and considerable demand will exist in the textile industries for such workers: this should not be without interest for those engaged in the training of students in our universities.

The Ministry of Agriculture and Fisheries has re-issued Leaflet No. 71, dealing with the Colorado beetle. The discovery of this destructive insect in the neighbourhood of Bordeaux last year renders it necessary to take any precautions possible in order to guard against its entry into this country. On several occasions it has been carried by shipping to Europe, and has even become temporarily established on a small scale. During 1901–02 it occurred in potato plots in the neighbourhood of Tilbury docks, but was successfully eradicated by prompt measures. The present infestation in France is of a most serious nature, and it is known to have spread over about 100 square miles. In all probability its area of occupation is even larger, as it is difficult to investigate so large a district with equal thoroughness. The reappearance of the insect during the coming season will be watched with some anxiety, and, unless the most drastic measures are taken on a very large scale, there is every chance that it will remain, and ultimately establish itself as a continental pest. In the latter event it can be scarcely more than a matter of time before it reaches England, since it is obviously impossible to prevent stray insects coming over unobserved in vessels from Bordeaux. The potato in this country is singularly free from insect pests, and it is to be hoped that the Colorado beetle will be unable to establish a footing. It is, however, gratifying to know that the Ministry of Agriculture has given the matter the fullest consideration; but it is incumbent upon all growers to inform the Ministry of the first sign of the appearance of the insect in the field, in order that it can be dealt with immediately by experts. There is no doubt that it can be eradicated if measures are taken sufficiently early; but it is evident that in France it has spread and multiplied to an extent which renders effective control a matter of great difficulty.

In the issue for March 9 of *Chemistry and Industry* appears a review of the position of the nitrogen industry in France. The French Chamber of Deputies has recently approved the agreement made in November, 1919, with the Badische Anilin und Soda Fabrik, whereby the French were to pay 5,000,000 francs for the right to work the Haber process, together with all information necessary to carry on the process as worked at Oppau and Merseburg. Part of this sum would be paid on the ratification of the agreement, and the remainder when the factory has produced a minimum of 20 tons of fixed nitrogen per day for fifteen consecutive days. A royalty would also be paid when production reached a certain figure. The agreement has given rise to much discussion of the merits of the Haber and other processes. An inquiry instituted by the French Government in 1921 led apparently to the conclusion that under existing conditions the Haber and Claude processes offered practically equal advantages, and the matter can be settled only on the basis of experience gained in working the various processes on a large scale over a considerable period. (Cf. Nature, vol. 107, page 765; vol. 111, page 101.)

Several new flying records were established during February, according to the *Meteorological Magazine* for March. A record climb of 20,000 feet in 12 min. 24 sec. by Flight-Lieutenant Haig at Martlesham Heath is noted as announced in the *Times* of February 6. The speed at ground level was 189 miles per hour. At Marseilles, on February 15, M. Sadi Lecointe is said to have broken the world's record for speed over a four-kilometre course: his average speed was 234⅝ miles per hour, breaking the previous record by more than 10 miles per hour. Another French airman, M. Maneyrol, on February 26 established a record, making a motorless flight of 10 kilometres (horizontal distance) near Cherbourg during a strong south-westerly wind. Three notable flights are said to take place this year: an expedition of five French aeroplanes was to start on March 15 on a world tour, probably lasting two years. An American crew will fly from Berlin to Chicago, towards the end of the year, in the Zeppelin air-cruiser now being constructed for the American Government. A flight across the North Pole is to be attempted at the end of June in connexion with Amundsen's expedition; the distance to be covered is 2250 miles, and it is expected to fly this distance from Point Barrow to Spitsbergen in 26 hours.

We are asked to announce that the Museum of Practical Geology, 28 Jermyn Street, S.W.1, is closed for repairs until further notice. The offices and library of the Geological Survey remain open.

The Brussels correspondent of the *Times* states that it has been decided to begin Summer Time in Belgium on April 21.

On Thursday next, April 26, at 3 o'clock, Prof. J. T. MacGregor-Morris will begin a course of three lectures at the Royal Institution on "Modern Electric Lamps," and on Saturday, April 28, Dr. Leonard Williams will deliver the first of two lectures on the "Physical and Physiological Foundations of Character." The Friday evening discourse on April 27 will be delivered by Prof. C. V. Boys on "Measurement of the Heating Value of Gas," and on May 4 by Prof. Soddy on the "Origins of the Conception of Isotopes."

At a quarterly meeting of the council of the Royal College of Surgeons of England, held on April 12, the

Jacksonian Prize for the year 1922 on "The effects produced by radium upon living tissues, with special reference to its use in the treatment of malignant diseases," was awarded to Mr. H. Sidney Forsdike, of the Soho Hospital for Women. Sir Arthur Keith was elected Vicary lecturer for the ensuing year.

Dr. H. H. Dale, head of the department of biochemistry and pharmacology of the Medical Research Council, the Rev. G. Milligan, Regius professor of divinity and Biblical criticism in the University of Glasgow, and the Very Rev. Dr. W. F. Norris, Dean of York, have been elected members of the Athenæum Club under the provisions of the rule of the club which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

The Institute of Physics admits physicists to a grade of associate membership, and it is believed that there must be a large number of young physicists at present outside the Institute who are eligible for this grade. All students and others who have conducted a year's work of satisfactory research are eligible if they have a degree of approved honours standing, or if they pass the equivalent examination of the Institute. Ultimately, it is probable that the associate group will be much larger than that of fellowship, and that new fellows will be selected mainly from it. The Institute has now an appointments register, and many applications for young physicists have been received from manufacturing firms and research laboratories. Regulations for admission to the Institute can be obtained from the secretary, Mr. F. S. Spiers, 10 Essex Street, Strand, London, W.C.2.

At the meeting of the Royal Geographical Society held on April 9 the president announced that H.M. the King had been pleased to approve the award of the Royal Medals as follows: The Founder's Medal to Mr. Knud Rasmussen for his exploration and research in the Arctic regions during the last twenty-five years; the Patron's Medal to the Hon. Miles Staniforth Cater Smith for his explorations in the unknown interior of Papua. The council has awarded the Murchison Grant to Capt. A. G. Stigand for his map of Ngamiland; the Back Grant to Mr. B. Glanvill Corney for his studies in the historical geography of the Pacific; the Cuthbert Peek Grant to Messrs. R. A. Frazer and N. E. Odell to assist them in continuing their explorations of Spitsbergen; and the Gill Memorial to Capt. Augiéras for his journey in 1920–1921 from Algiers to Mauritania.

Preliminary notice has been issued of the arrangements for the Hull congress of the Royal Sanitary Institute to be held on July 30–August 4. An inaugural address will be delivered by the Right Hon. F. R. Ferens on the first day of the meeting; on July 31, Sir Alexander Houston will lecture on "A Pure Water Supply," and a popular lecture on "Industry and National Welfare" will be given by Mr. B. Seebohm Rowntree on August 2. The congress will meet in four sections dealing with sanitary science, engineering and architecture, maternity and child welfare including school hygiene, and personal and domestic hygiene, respectively, and there will be numerous conferences of sanitary inspectors, health visitors, medical officers of health, veterinary inspectors and representatives of sanitary authorities. During the congress, a Health Exhibition will be held in the Wenlock Barracks.

The annual report of the director of the Field Museum of Natural History, Chicago, for 1921, is written by D. C. Davies, who succeeded the late F. J. V. Skiff on December 19 of that year. The chief event chronicled is the re-opening of the museum in its new building (which is, we believe, in Grant Park) on May 2, 1921. The opportunity has been taken to place on exhibition for the first time a skull of the northern mammoth, found in gold-mining at a depth of 100 feet at Woodchopper Creek, Alaska. The specimen is represented on a Plate. Among accessions is to be noted the collection of Lower Palæozoic fossils made, chiefly from Ohio localities, by the late C. B. Dyer. The bird collection has been enriched by a large number of albinos and specimens of abnormal coloration. The removal of the museum has led to a large increase in the number of visits, especially by school children.

At the Boston meeting of the American Association for the Advancement of Science in December last, the centenary of the birth of Gregor Mendel and Sir Francis Galton was celebrated by a series of addresses which are published in the March number of the *Scientific Monthly*. Prof. E. M. East dealt with "Mendel and his Contemporaries." Prof. T. H. Morgan, in a paper on "The Bearing of Mendelism on the Origin of Species," points out that small mutations are really the material on which Darwin chiefly relied to furnish a basis for evolution. He also discusses the question of species sterility, and points out difficulties of evolutionary interpretation which may arise from the occurrence of parallel mutations. Dr. J. Arthur Harris compares the influence of Mendel and Galton on the history of biology, and concludes that the latter has had a more varied and far-reaching effect on the history of science. Finally Prof. G. H. Shull asks for donations to a "Galton and Mendel Memorial Fund," the money to be applied to the publication of expensive illustrations in the journal *Genetics*.

We have received from Messrs. Ridsdale and Co., of Middlesbrough, a report on the second period of three years in the preparation and use of a series of chemical standards prepared by this firm, with the voluntary co-operation of a number of analytical chemists throughout the country. The report was submitted to a meeting of the co-operators held recently at York. Very thin turnings of steel are now being used to facilitate the determination of carbon by combustion. The series of standards now available includes the whole range of carbon steels, together with four alloy steels, two cast irons, and a basic slag. Certain resolutions were passed at the meeting, urging the desirability of extending the use of chemical standards for analysis, and the establishment of a more formal organisation on a firmer financial basis. These standards are now widely used, and the movement seems likely to become self-supporting, some 15 or 20 co-operators taking part in each standardisation, and the number of users, both at home and abroad, being large.

Under the title *Capita Zoologica*, a new quarto Dutch zoological periodical has recently appeared. It is issued under the editorship of Prof. Dr. E. D. van Oort, director of the State Museum of Natural History at Leyden, and is composed of transactions on systematic zoology, each part forming a complete work which is sold separately. A number of transactions will form a volume of about 500 pages, with plates and engravings. The contributions are published in English, French, and German. The part before us of this well-executed publication is Deel 1, Aflevering 4 (1922, price 24 guilders), and is devoted to a description of flies of the group Dolichopodinæ of the Indo-Australasian region by Th. Becker. It is evidently an important contribution by this recognised authority, and extends to nearly 250 pages, 222 illustrations occupying 19 plates. The previous three parts of this journal deal respectively with Nematodes, by Dr. J. G. de Man; Rhizostomes, by Dr. G. Stiasny; and Oligochætes, by Prof. W. Michaelsen.

We have received from Messrs. Pastorelli and Rapkin, Ltd., of 46 Hatton Garden, E.C.1, a new catalogue of chemical thermometers. All the instruments listed are stated to be of British make, and as a guarantee of this the thermometers bear the name "Britgla," the registered trade mark of the British Lampblown Scientific Glassware Manufacturers Association, Ltd. The list in question is very comprehensive and covers a variety of ranges from −30° C. to 600° C. Thermometers with corresponding ranges on the Fahrenheit scale are listed in most cases. The ranges are varied in such a manner that it should be possible to select a reasonably open scale thermometer for any temperature. Quotations are given for two main classes of thermometers, namely, low-priced chemical thermometers and best quality standard laboratory thermometers. We are pleased to note that in both classes there is a considerable reduction in the prices which have been prevailing of late years. For convenience, the cost of supplying National Physical Laboratory certificates with the latter class of instruments is shown separately. A special section is also devoted to high range thermometers constructed of borosilicate glass and nitrogen-filled. These can be supplied in metal sheaths for industrial use.

Part 3 of volume 1 of the Abstract Bulletin of the Research Laboratory of the Lamp Works of the General Electric Co., Cleveland, Ohio, deals with 36 researches recently published, and extends to nearly 220 pages. It has been found advisable to expand the pure and applied sections of the laboratory into two separate laboratories for pure and applied science under the directions of Dr. E. F. Nichols and Mr. M. Luckiesh respectively. Both laboratories contribute to the researches abstracted in the present part. As an illustration of the thorough way in which industry in America is going into the scientific and technical questions which underlie manufacturing processes, we would direct attention to a paper of 32 pages by Mr. Luckiesh on the physical basis of colour technology, in which the methods used to investigate, by the help of the spectro-photometer, the properties of the dry pigments used in the paint industries, of the dyes, their mixtures and solutions, and of the various substances used in producing coloured glasses, are described. With data of the kind described available, many of the difficulties and obscurities of the colour industries are removed, and progress becomes rapid, while without them much groping in the dark is inevitable.

Part F of the "Guide-book of the Western United States" has just been issued as Bulletin 707 of the U.S. Geological Survey. Its author, Marius R. Campbell, writes for the tourist who looks with an intelligent interest from the windows of his parlour-car on the "Denver and Rio Grande Western Route"; but side-excursions are duly encouraged and described, and the maps show, in brown stippling, some ten miles depth of country on either side of the adventurous line. Numerous illustrations are given of the scenery along the route, which starts from Denver and ends at Salt Lake City. West of Canon City (not "Cañon" or "Canyon," be it observed) the railroad enters the Royal Gorge of the Arkansas River, which is cut 1000 ft. sheer in pre-Cambrian granite, overlain by stratified rocks of Upper Cretacous age. We are shown the fantastic arid weathering of the rose-red Permocarboniferous sandstone in the famous Garden of the Gods, and Pike's Peak appears as a portion of a snowy range. The ancient local glaciation of Colorado is not neglected, and the time-honoured error as to the origin of the term *roches moutonnées* is once more repeated on Plate 55. The protected fauna is illustrated, and the fauna that tried in vain to protect itself at the opening of Cainozoic times is finely represented by restorations of Stegosaurus and Triceratops. Stegosaurus, by the bye, means "roofed lizard," not "plated lizard." This and the other guide-books of the series must not be overlooked by those who travel in America, and they contain much geographical and geological information which is rendered accessible in European libraries, through the generosity of the Survey, for those who may never cross the Atlantic.

Bulletin No. 133 of the Engineering Experiment Station of the University of Illinois is entitled "A Study of Explosions of Gaseous Mixtures," by Prof. A. P. Kratz and Mr. C. Z. Rosencrans. The report contains a valuable bibliography of the subject, beginning with Dalton and Humphry (not "Humphrey" as in the report) Davy, and after passing in review such classical researches as those of Dixon, Berthelot, Petavel, Bone, Jouguet (not "Jouget," as in the report), Thornton, and others, the literature references are carried up to 1921. A brief summary of this work, and some new experiments by the authors are given. The report will prove useful to all who are interested in this very important subject.

Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1, have just issued a valuable catalogue (No. 100) of upwards of 2600 second-hand science books and serials which they have for disposal. The list is conveniently arranged under the headings—ornithology, entomology, conchology, the lower invertebrates, general zoology, botany, horticulture, agriculture, geology, mineralogy, astronomy, mathematics, engineering, and early medical works. It should interest many readers of Nature.

Among the books shortly to be published by the Oxford University Press is "The Glass Palace Chronicle of the Kings of Burma," which has been translated for the Burma Research Society by Pe Maung Tin and G. A. Luce. The chronicle is the work of the committee of "learned monks, learned brahmans, and learned ministers" appointed in 1829 for the purpose by King Bagyidaw of Burma. The title is taken from the Palace of Glass, in a chamber of which the compilation was made.

Our Astronomical Column.

Greece adopts the Gregorian Calendar.—The Gregorian Calendar was adopted for civil purposes in Greece from the beginning of March. As Russia has apparently taken the same step, the old or Julian style becomes practically obsolete. M. D. Eginitis, director of the Athens Observatory, contributes a paper to the *Comptes rendus* of the Paris Academy of Sciences, March 12, in which he notes that the finding of the decree of Nicæa, A.D. 325, shows that, far from prohibiting such a change, it in reality rather demands it. The decree simply directed that Easter should everywhere be kept on the same day; by implication this day was the first Sunday after the 14th day of the first lunation after the spring equinox, which was assumed to occur on March 21. When it was found that the Julian Calendar did not maintain the equinox at this date, the reform at once became appropriate. The causes that for so long retarded its acceptance in eastern Europe were largely removed by the War, and M. Eginitis addressed a memorandum to the Greek Government in December 1918, which has now been followed.

The Greek Church is not at present adopting the reform, the reason being the expectation of the speedy adoption of other calendar changes in the west, for which it prefers to wait.

Some of these reforms are being discussed by the International Congress of Chambers of Commerce now meeting in Rome; but experience shows the extreme difficulty of persuading the world to adopt changes in their fixed habits, however desirable in themselves, so that we can scarcely share the sanguine view of M. Eginitis, who shares the expectations just mentioned.

The Eighth Satellite of Jupiter.—Prof. E. W. Brown contributes an article on this satellite to *Astronom. Journ.* No. 817. He makes use of Delaunay's algebraical expressions for the various terms, which are theoretically available for any satellite; however, in cases of such large eccentricity and inclination as those of J. VIII the terms do not converge rapidly enough to be used straight away. Prof. Brown, whose great experience gained in his new lunar theory comes useful, shows how estimates may be made of the remainders, and in particular finds a solution for the mean motion of the perijove. The general rule both with planets and satellites is that the apse moves in the same direction as the body, but in the case of J. VIII the higher terms of the series reverse the earlier ones, and produce motion in the opposite direction. Prof. Brown refers in his work to G. W. Hill's paper on the motion of the lunar perigee; it is interesting to recall that it was this work of Hill's that gave Brown the idea that he afterwards followed so successfully in his lunar theory.

The period of revolution of the perijove of J. VIII is about 800 years, an unusually long period for a satellite. It is welcome news that Prof. Brown proposes to continue his work till he has arrived at expressions which will enable the place of the satellite to be predicted without the tedious method of mechanical quadratures. Mr. J. Jackson has also been at work on the satellite, using a combination of observed and calculated positions, and gives an ephemeris for the present apparition in the *Observatory* for March. The chief importance of observing this satellite and the still fainter J. IX is that they will ultimately give a better value of Jupiter's mass than any other method.

Astronomy in the United States.—The section of Year Book, No. 21, of the Carnegie Institution of Washington, dealing with astronomical work carried out in departments of the Institution includes several items of general interest. The so-called K-term in radial velocities, that is, an average motion of recession shown by all spectral types, but especially by type B, where it amounts to 4 km./sec., is discussed. More than half of this is removed by adopting newly determined wave-lengths for the lines of oxygen, nitrogen, silicon and helium that were used; it is further pointed out that certain lines formerly used were double, and therefore unsuitable. A small residual recession may be due to the Einstein effect. Work on the proper motions of the red stars has shown that these are generally small in the case of types M and N; M stars have large radial velocities, they are therefore mainly giants, and very distant. The radial velocities of type N stars are small, indicating that their average mass is high. Both types give much the same direction for solar motion as that generally adopted.

Studies have also been made on the progressive differences of spectra from type B0 to B8. In B8 the oxygen and nitrogen lines disappear, while a number of enhanced metallic lines appear; it is anticipated that discussion of these facts may advance the theory of ionisation, and our knowledge of the constitution of matter.

The meridian observers seem to be worked very hard; they are on duty for a week at a time, and observe time-stars at intervals not exceeding 6 hours, besides circumpolars at both culminations. What would the advocates of an 8-hour day say to this? The object is to eliminate personality, but it is found that when an observer is fatigued he observes differently than he does when fresh. One of the objects of this series of observations is to determine the laws of differential refraction both in Right Ascension and Declination, and if possible to connect it with the meteorological conditions. There is little doubt that differential refraction is the cause of the perplexing variations in time-determinations from different observatories, and that its determination would mean a marked increase of accuracy in meridian work.

Research Items.

Bone Harpoons discovered in Yorkshire.—In 1922 Mr. A. Leslie Armstrong described in *Man* two bone harpoons said to have been found at Hornsea, West Yorkshire. At the Hull meeting of the British Association the harpoons were again exhibited, and Mr. Sheppard, curator of the Hull Museum, questioned their authenticity on various grounds. The matter having been brought to the notice of the Council of the Royal Anthropological Institute, a committee, consisting of Sir C. H. Read, Dr. A. Smith Woodward, and Prof. Percy F. Kendall, was appointed to investigate the matter. The report of the committee is published in the April issue of *Man*. The members report that there is no evidence in the objects themselves that is conclusively against their genuineness: that the similarity of the barbs in the two examples, though found 4 miles apart, points to the conclusion that they are the work of the same individual. "It is worthy of remark that at the time the earlier find was made there was no available example of a Maglemose harpoon." "Mr. Sheppard appears to have had strong grounds for doubting the authenticity of the harpoons, but the evidence on which his judgment is based is no longer verifiable."

Baby Clinic Statistics.—No. X. of the "Studies in National Deterioration" (Cambridge University Press, 15*s*.), forming a subsection of the series of Drapers' Company Research Memoirs, is a thorough analysis of data provided by a baby-clinic in a large manufacturing town, carried out by Miss M. N. Karn and Prof. Karl Pearson. The authors have made very full use of the method of correlation and reach various conclusions of interest and practical importance. Two of these may be noted. The first is that there is a considerable if not very large (0·37–0·43) correlation between the health of an infant at birth and at the end of the first year, a result compatible with general biological considerations, incompatible with the catch word "all babies are born healthy." The second is that although the use of a baby "comforter" is associated with ill health over the full period of observation, the correlation is almost doubled when the health of babies under 14 days old is correlated with use of a comforter. The most plausible interpretation is that the delicate babies are preferentially supplied with comforters rather than that the comforter itself is an important cause of ill health. Those readers who are not versed in the correlational calculus will find the numerous diagrams helpful.

Botany in India.—The report for 1921–22 of Lieut.-Col. A. T. Gage, the director of the Botanical Survey of India, directs special attention to the appearance of Parts I. and II. of the "Botany of Bihar and Orissa," by Mr. H. H. Haines. These two parts contain the description of 70 families, from the Ranunculaceæ to Cornaceæ. Part IV. of the "Flora of the Presidency of Madras," by Mr. J. S. Gamble, has also appeared, containing the families Rubiaceæ to Ebenaceæ. The most interesting economic development in progress appears to be the promotion of cinchona planting in Southern Burma under the superintendence of Mr. P. T. Russell. Cinchona seedlings were planted out in May 1921, on a site near the Heinze river at an elevation of 1700 feet. Unfortunately this situation proved to be apparently "the point of impact of the very arrow head of the monsoon"; during June, July and August more than 240 inches of rain fell and more than half the seedlings succumbed. The survivors have since been growing very well, but it is proposed to recommence operations farther south in the Tenasserim Division of Burma, where the rainfall is both less in amount and more evenly distributed over the year. The cultivation of Ipecacuanha has apparently commenced very successfully on an experimental scale in Southern Burma, the temperature being more equable in this climate than in the Eastern Himalayas where this plant is grown.

Genetics and the History of Wheat.—The Maine Agricultural Experiment Station continues to be prolific in genetic results, the chief contribution being from Drs. Karl Sax and John W. Gowen. In an important paper on sterility in wheat hybrids (*Genetics*, vol. 7, p. 513), Dr. Sax continues his work, in which it is shown that the three groups of wheat species, namely, the Einkorn, Emmer, and Vulgare groups, have respectively 7, 14, and 21 chromosomes as their haploid numbers. He has now investigated the chromosome behaviour in various hybrids between these different groups and finds conditions very similar to those obtained by Rosenberg, Gates, and others in similar hybrids. In crosses between members of the first two groups there are, for example, 7 bivalent and 7 single chromosomes, the latter separating at random when the former split. The origin of the tetraploid and hexaploid conditions in wheat is also discussed. Prof. Percival has shown that all three of the groups of wheat can be traced back to prehistoric times, Einkorn being grown in Central Europe in Neolithic times, Emmer and Vulgare also being prehistoric in Europe, and the former dating back to 5400 B.C. in Egypt. All the groups are therefore of sufficient age for a considerable evolution to have taken place within them. The higher numbers of chromosomes appear to have arisen by duplication of the original set of 7 pairs. This would mean also duplicating the hereditary factors present. Now in wheat, 14 different characters are known to be dependent on one factor, 4 depend on two factors, while only the red grain colour is represented by three independent factors. Hence it would appear that in the polyploid wheats most of these factors had arisen as mutations after the origin of the tetraploid and hexaploid conditions. Prof. Percival considers that the Vulgare (hexaploid) group arose as a hybrid between *Triticum aegilops* and a member of the Emmer (tetraploid) group. The study of the chromosomes is clearly of the greatest importance in tracing the history of our cultivated crops. The species of Avena (oats) show a similar series of chromosome numbers. Polyploid wheat hybrids produce small or wrinkled seeds. The endosperm in a cross between tetraploid and hexaploid forms may contain $14 \times 2 + 21 (= 49)$ chromosomes or $21 \times 2 + 14 (= 56)$ chromosomes according to which is the male parent, as the female parent contributes two nuclei. These unbalanced conditions result in abnormal development of endosperm.

Infection and Cytological Studies of Plasmopara.—In the Journal of the College of Agriculture, Hokkaido University, Sapporo, Japan, Vol. XI., Part 3, Makoto Nishimura gives a description of the methods of infection and of fertilisation of *Plasmopara Halstedii* Farlow, parasitic upon *Helianthus annuus* and other Composites in America. Although published in Japan this work was carried out at Columbia University under the guidance of Prof. R. A. Harper. The most striking feature of the infection experiments is the demonstration of zoospore infection through the roots, the zoospores apparently penetrating the middle lamellæ in the absorptive region of the root.

Oospores were freely formed by the fungus, especially in the roots of the host, but also in stem and leaf, and fertilisation was studied in properly fixed and microtomed material. An interesting description is given of a large "receptive pupilla" of the oosphere which protrudes into the antheridial cell at first, in a manner that recalls Murphy's description of fertilisation in *Pythium erythroseptica*. Afterwards this protrusion is withdrawn and apparently its retraction conducts the fertilisation tube from the antheridium into the centre of the oosphere. One nucleus is discharged through this tube into the oosphere from the antheridium.

United States Geodetic Survey.—The annual report of the United States Coast and Geodetic Survey for 1922 contains a long record of work accomplished during the year. Hydrographic surveys were carried out principally in the approaches to Chesapeake Bay, off northern California, in the waters of south-east Alaska, and the Philippine Islands. New charts, to the number of 27, were published to cover all areas for which adequate data were available. In some areas, principally Alaskan waters, the production of new charts is delayed until the primary triangulation is completed. The aerial survey of the Mississippi delta was finished and promises such favourable results that an extension of this means of coastal survey is projected. Outstanding features of the geodetic work of the Survey were the completion of the 1600-mile arc from Huntsville in Alabama to Williams in Arizona by way of Memphis and Albuquerque. This arc furnishes accurate positions in seven states and crosses an area badly in need of horizontal control. Work was continued on several other arcs, including one from Dixon Entrance to White Pass, Alaska, which is part of a long arc from Puget Sound, in which the Canadian Geodetic Survey is co-operating. Good progress was made in precise triangulation in Alaska. The Survey is co-operating with a committee of scientific workers in making an intensive study of earthquake phenomena. Magnetic work and tidal observations were extended during the year. The director points out the need for investigations on the Atlantic coast and particularly for the exploration of the Gulf Stream. He urges also that oceanographical work should be undertaken in the Atlantic outside the 100-fathom line and in the Pacific beyond the 1000-fathom contour. Lastly, he emphasises the amount of wire-drag work that must be done along the coasts in the interests of navigation.

The Crumpling and Rifting of Earth-Blocks.—Otto Baschin, of Berlin, in *Die Naturwissenschaften* for February 9, directs attention to what he believes to be a hitherto unnoticed factor in the tectonics of the earth's crust. He starts by the admission of considerable vertical movements of elevation and subsidence in the crust, and these are probably of an order that Wegener's hypothesis rejects. Baschin urges that a rising earth-block, as it comes into a region with greater rotational velocity than that in which it previously lay, becomes a retarding influence in its new surroundings, and in consequence exerts a pressure towards the west. Similarly, a sinking block is an accelerating factor and exerts a pressure to the east. If a continental block sinks on the east side of a line running north and south, and rises on the west, rifting may occur along the line; if it rises on the east and sinks on the west, compression and axial folding are set up. Other cases are of course considered, and the drifting of blocks towards the equator (*Polflucht*) is discussed.

The Laramie Problem of the Rocky Mountain.—The coal-bearing beds of the Rocky Mountain region have now been the subject of a considerable literature, and in Professional Paper 130 of the U.S. Geological Survey (Washington 1922), F. H. Knowlton presents a useful review of the progress of what is known as the "Laramie problem." In 1875 this problem led Cope to the conclusion that there was no alternative but to assume the possibility "that a Tertiary flora was contemporaneous with a Cretaceous fauna, establishing an uninterrupted succession of life across what is generally regarded as one of the greatest breaks in geologic time." The term Laramie itself arose out of the need for a non-committal term for beds regarded by Clarence King, then at work upon the exploration of the fortieth Parallel, and by F. V. Hayden, busy with the survey of Northern Colorado, as certainly conformable, although it was regarded by King as Tertiary and by Hayden as Cretaceous. Knowlton, having shown that the work of Lee and himself makes clear the existence of an unconformity in the midst of the coal-bearing so-called Laramie rocks of Colorado and New Mexico, points out that when their flora is studied in detail the strata below the unconformity are Cretaceous, and those above Eocene. This work, based upon a long study of all the main collections of plants from these strata, has been in progress since 1889, its publication being delayed until its author was clear that the long-standing problem was definitely in process of settlement. The flora so carefully studied is not in itself extensive, and the preservation of the plant impressions in the soft friable sandstone is far from perfect. The specimens are very fully described, and are figured in 28 plates, some pen drawings, and photographs.

Osage Oilfield, Wyoming.—The Osage Oilfield, Weston County, Wyoming, was developed as the result of the chance striking of oil on land adjacent to the Chicago, Burlington, and Quincy Railroad in 1919, and there sprang into existence, within a year after this discovery, a town having a population of more than 1500 persons, possessing well-built roads and buildings in addition to the usual field equipment in connexion with the production of petroleum and its products. During the same period more than 200 wells were drilled, pipe-lines were laid, and a refinery with a capacity of 500 barrels of oil per day was established. According to investigations by A. J. Collier, published as a bulletin of the United States Geological Survey (No. 736-D), in 1921 the Osage field had an average daily output of 550 barrels of oil; several gas wells were giving collectively 500,000-1,000,000 cubic feet of gas per day, and some eight or nine *flowing* wells yielded a good supply of water (a characteristic feature of this part of the State). Production of oil was maintained during that year from about 100 good wells. Stratigraphically the rocks belong essentially to the Cretaceous system and are of typical Rocky Mountain region facies. The Colorado group, containing the Newcastle sandstone, is the important series of deposits from the point of view of petroleum production. Structurally the field is related to the Black Hills uplift lying to the N.E., and the general dip of the rocks is to the S.W., at about 5° where normal. Minor corrugations in what is otherwise a simple monoclinal structure determine the presence of local anticlines and of the oil. The oil-pools are formed by moderately porous sandstones (about 19 per cent. average porosity) occurring as lenses within the shale formations, and the oil itself is of a light olive-green colour, low specific gravity, and high petrol content.

Climatic Continentality and Oceanity.

By L. C. W. Bonacina.

Not much less important among the geographical factors which determine climate than latitude and altitude, is the relative distribution of land and sea, or, in short, continentality *versus* oceanity, and in view of the somewhat large class of students who encounter this aspect of climatology it seems desirable to direct attention to a couple of German maps which have recently appeared indicating the distribution of continentality over the globe as a whole and over Europe in detail (*Petermanns Mitteilungen*, June 1922, R. Spitaler after G. Swobodna).

It is possible to represent the mean or normal temperature of a particular latitude at any time of the year in an equation involving, also, the intensity of insolation and the relative distribution of land and water in the neighbourhood; and therefore it comes about that there is a means of seeing how the temperature of a given point in summer, winter, or the year as a whole, compares, on one hand, with full "continentality" such as would uniformly prevail over a hemisphere covered entirely with land, or, on the other hand, with full "oceanity" such as would characterise an entire water hemisphere. The maps in question are based upon the annual range of air temperature between January and July, but are not quite the same thing as simple maps of equal annual range would be, because the annual range is to some extent affected by differences of latitude which are allowed for in the relationship just referred to. Taking full "continentality" as 100, and full "oceanity" as 0 (zero "continentality"), lines of equal percentage value are drawn across the entire map of the world except the inter-tropical belt, uncertainty for which attaches to the fact that the significance of the seasons is not the same as it is in extra-tropical latitudes.

There is a large area in the interior of North America with 90 per cent. continentality, the Sahara region and much of Western Asia with 100, and a considerable portion of Eastern Asia suffering from a super-continentality amounting to as much as 130. This is explained by the abnormal winter cold of Central Asia, due to a certain type of atmospheric circulation set up over this great land-mass, which results in a local degree of continentality greater than that proper to a uniform land hemisphere. A high degree of continentality also prevails over the land-locked North Polar basin where the ice-covering raises the percentage of the Arctic Ocean to near 100. At the other end of the scale we find 5 per cent. (95 per cent. oceanity) over that part of the North Atlantic between Iceland and Norway, and 0 (full oceanity) over much of the oceanic areas in the Southern Hemisphere, while local regions in the South Pacific and the Southern Ocean, under a special trend of sea and air currents, experience a slight degree of super-oceanity amounting to -5 per cent. on the continentality scale (105 oceanity). In consequence of the circulation of the atmosphere there are regions where continentality trespasses upon the sea, *e.g.* the Yellow Sea and Sea of Okhotsk with 70 per cent., and where oceanity invades the land, *e.g.* England and France with 20 to 45 per cent., values actually lower than that of the land-locked Mediterranean Sea, which averages about 45 per cent.

It is clear, therefore, that these maps show something more than the simple effect of local land and sea influences upon the annual range of temperature, and it would have been instructive to have a cartographical representation of this effect as well, uncomplicated by the effect due to the transference of continental and oceanic conditions beyond their respective domains. If one turns, for example, to the more detailed map of Europe, there is 10 per cent. continentality along the west coasts of Ireland and Scotland, and the 50 per cent. line, marking the boundary between the "continental" and "oceanic" parts of the continent, driven back by the prevailing Atlantic winds to the longitude of eastern Germany except for outliers around Spain, Switzerland and Sweden. Even the neighbourhood of London, the most continental portion of the United Kingdom, has a percentage no higher than 27, and the generally low value, about 25 per cent. for England as a whole with a position fairly well balanced as between land and sea, unmistakably reflects the dominating influence of the prevailing oceanic winds. There can be little doubt, indeed, that if the south-east of England were normally controlled by a stagnant contracyclonic system of circulation allowing more local temperature controls to gain the ascendant, the continentality would rise to near 50 per cent., and to near 75 per cent. if the prevailing winds were continental east winds instead of the actual oceanic west winds. This conclusion is strongly supported by the high degree of continentality, about 70 per cent., which prevails on the east coast of the United States in consequence of the westerly circulation from the interior of the continent.

Instructive as these German maps are, they do no more than touch the fringe of the subject inasmuch as there are other criteria by which thermal continentality may be judged, namely, diurnal range of temperature and the magnitude of irregular deviations from the normal, both of which run roughly, but not exactly, parallel with the seasonal or annual range above considered. It could be shown, for example, that in relation to the inland parts of England the east coast is somewhat more "continental" according to annual range than according to diurnal range of temperature. This is because the short-period range between day and night is more definitely influenced in the long run by local distance from the sea, whereas the seasonal range of temperature is more markedly affected by continental types of weather, transporting summer heat or winter cold, on the east coast than it is farther west.

Interesting, too, is the study of continentality from the point of view of deviations of particular seasons from the normal, and here a striking lesson is afforded by the climates of London and Paris. The French capital on the average of a long series of years is 2° F. colder than the English in January and 3° F. hotter in July, the greater difference in summer being apparently due to the more southerly latitude, which would work with the continentality difference in the warm season but against it in the cold. Yet it is during occasional periods of severe cold that the more violent continentality of Paris is so emphatically demonstrated. The month of December, 1879, was, on the continental mainland, one of unparalleled rigour, the mean temperature day and night for the entire month in Paris being so low as 18° F., or some 20° below the normal. But the coldest December ever recorded in London, that of 1890, a month of appalling gloom and as cold as any winter month that has occurred since the establishment of records, had a mean temperature not lower than 29° F., or only 10° below normal, while the same month in Paris was 12° below, or only less cold than 1879. There are many similar instances of wider departures from the normal on the other side of the Channel.

Facts of this kind constitute an obtrusive aspect of climate, but they are apt to be eclipsed in the common practice of limiting one's studies to means and averages.

Discovery of Marine Beds at the Base of the Gondwana System in Central India.

MOST of the papers recently published in the Records of the Geological Survey of India naturally take the form of shading with details the general outline previously known. Some of the results published in the last general report of the director (Records, Geological Survey of India, vol. 54, Part 1) are, however, of special interest as showing that some of the previously accepted outlines need reconsideration. We have space to notice only one of them at this stage, and that because the director's announcement may not be superseded for some time by a more detailed description.

Among the results hitherto regarded as final has been the conclusion that the Peninsula of India has never been submerged beneath the sea since early Palæozoic times, except for narrow strips extending not far from the present coast lines. Towards the end of 1921, however, the discovery by Mr. K. P. Sinor of a very thin marine bed at the base of the Lower Gondwana system, on the small coalfield at Umaria in the Rewah State of Central India, suggested a review of the previously accepted view regarding the stability of the peninsular *Horst*. Early last year, after this discovery had been reported to the director of the Geological Survey of India, a field collector was deputed to obtain further specimens, and these included, besides Productus, a species of Spiriferina related to and probably identical with *Spiriferina cristata* var. *octoplicata*.

This discovery thus unexpectedly provides evidence of the fact that the sea in Carboniferous times trespassed on to the continent of Gondwanaland farther than was previously suspected; for the Umaria coalfield is some 500 miles from the present west coast, 400 miles from the east coast, and 400 miles from the marine formations which lie away to the north of the crystalline axis of the Himalayan range. In view of the fact that portions of the western States of Central India and the northern parts of the Bombay Presidency were invaded by the sea just before the outflow of the great Deccan trap early in Cretaceous times, one is tempted naturally to regard marine trespass from the west as the most natural line of advance and subsequent retreat; but there is a possibility also that this Productus bed in Rewah records the spread southward of the Permo-Carboniferous sea which left thick masses of Productus limestone in the Punjab, Kashmir, and Tibetan plateau.

The discovery is thus one of very great interest to students of geomorphology; but though doubtless the basal (Talchir) rocks of the Gondwana system will now be searched afresh with renewed hope, the chances of finding further evidence are remote. The coal seams of peninsular India all lie above the Talchirs, and mining operations naturally are not carried below the coal beds for purely scientific objects, while it is only around the edges of the coal basins that narrow strips of the underlying Talchirs occasionally peep out. The surface is fairly flat—a soil-covered peneplain which is lapped over on its northern margin by the mantle of Gangetic alluvium of unknown thickness.

Some years ago this discovery would have had a double interest; for the problem of correlating the great freshwater Gondwana system with the standard stratigraphical scale was the occasion of some controversy due to differences of opinion which naturally follow indirect inferences from homotaxis. But twenty years ago characteristic members of the Lower Gondwana Glossopteris flora were found associated with Productus beds in Kashmir, whither presumably they were carried by one of the rivers then running from Gondwanaland into the great Eurasian ocean known to geomorphologists as Tethys. The base-line thus became definitely established and at a level in the vertical scale near that which W. T. Blanford and others had advocated from indirect evidence many years before. Blanford lived long enough to hear of the Kashmir discovery, which proved that in the Indian region the Productus marine fauna and Glossopteris land flora were contemporaneous. What polemics would have been saved, probably, if he had surveyed the Central Indian instead of the economically more important eastern coalfields, and had thus been able to start from a recognisable stratigraphical base line on the Peninsula itself.

The Calcutta School of Tropical Medicine and Hygiene.

THIS teaching and research institution was opened two years ago, and an account of its work is given in a paper by one of the staff, Major Knowles. The laboratory has four floors with 220 feet of north light and a shorter wing at right angles to the main front, while the special hospital for tropical diseases has more than 100 beds, both having been constructed and partially endowed at a cost of about 120,000*l.*, nearly two-thirds of which were raised by the founder, Sir Leonard Rogers, and by Major Knowles. The staff of whole-time professors and research workers now numbers thirty-three, special laboratories and investigators being provided for kala-azar, dysenteries, ankylostomiasis, leprosy (for which a separate institute is to be built opposite the school at a cost of another 20,000*l.*), diabetes and filariasis, all in addition to the teaching staff of the school. The departments now number seventeen, three or four sections commonly combining on one research under the director, Col. J. W. D. Megaw, thus furnishing the team work so essential to success.

The teaching is purely post-graduate, the number admitted being limited to 50 by strict selection. The course for the diploma in hygiene lasts nine months and that in tropical medicine six months, against four in the Liverpool and three in the London School of Tropical Medicine. After an hour's clinical work in the hospital, a lecture is given illustrated by numerous lantern slides, epidiascope pictures, and cinematograph films. This is followed by practical work in the class-rooms for the rest of the day illustrating the same subject, after which that lecturer is free for the rest of the week for research and preparation for his next class.

In the short time the Institution has been open, important work has been published, or is in the press, on the pathology and treatment of leprosy by Muir; on the diagnosis by a new test and the treatment of kala-azar by Napier; on the differentiation of chronic dysenteries by the reactions of the stools by Knowles and Napier; on the poisonous amines of dysentery and cholera bacilli, and also in lathyrism and epidemic dropsy by Acton, Chopra (professor of pharmacology), and S. Ghosh (chemist). Tropical skin diseases are being closely studied with the help of the full-time artist and the photographer of the school. Every case admitted is worked out clinically and microscopically by all the sections concerned, and careful records are kept. This cannot fail in due time to result in important additions to our knowledge of tropical diseases in view of the unrivalled clinical material available in the special hospital and in the 600 additional beds of the adjacent Medical College group of hospitals.

The new Institution is evidently destined to take a leading place in scientific medical research and teaching in the British Empire.

Virus Diseases of Plants.

HUMAN pathology has naturally had first claim upon the services of the investigator of disease, but a study of plant diseases is probably equally essential to human progress, and the timely review in *Science Progress* (No. 67, January 1923), by Dr. E. J. Butler, director of the Imperial Bureau of Mycology, bears eloquent witness to the great activity with which the special problems of plant pathology are now being attacked. It was only towards the close of the last century that the propagation of disease in plants was shown to be effected in some cases by a filterable virus, but since then facts and theories as to virus transmission have followed in rapid succession from various Continental and American laboratories. Very few observations have so far come from British laboratories, and it may be hoped that the very comprehensive and critical review presented by Dr. Butler will direct more attention to this fascinating field of work.

Many obscure conditions prevailing among growing plants should receive elucidation as a result of investigation into this problem, while the facilities the plant provides for experimental work may enable the whole mechanism of transmission by a virus to be submitted to a very critical analysis. For more than a century it has been known that in certain cases of variegation, if a branch bearing variegated green and white foliage be grafted upon a plant of the same species with normal green foliage, the variegated habit will slowly extend to the branches formerly bearing normal green leaves. This type of "infectious chlorosis" is still of obscure origin, and in this case, as with the curious "peach yellows," investigated in the United States, and in the "spike" disease of the sandalwood tree in India, grafting appears to be the only artificial method of transmission. All these puzzling abnormalities, varying from innocuous variegation to serious diseases such as the "spike" disease, which threaten to extinguish a profitable crop, may receive elucidation through the study of virus diseases more amenable to experimental treatment.

Among the diseases suitable for investigation, perhaps the best known are the "mosaic" diseases, so called from the patchy discoloration they usually produce upon the plant surface. Tobacco mosaic provides a remarkable case of transmission by a highly infectious virus which has been very thoroughly examined by H. A. Allard in the United States. In this case, if the hairs upon an infected plant are carefully cut with a sterile scissors, infection may follow if the hairs upon a healthy plant are then cut with the contaminated scissors. Originally considerable support was given to a theory that the infectious principle in tobacco mosaic was enzymic in nature, but Allard showed that, although ultramicroscopic, the infectious substance could be removed from the expressed plant juice by filters that left the oxidase activity of the juice practically unimpaired. However, the strongest argument in favour of an organism is furnished by dilution experiments in which the expressed juice, diluted to 1 in 10,000, still retains infectious properties. One of the most puzzling properties of the tobacco virus is its extraordinary stability to chemical reagents usually very toxic to living protoplasm and its resistance to relatively high temperatures. In the absence of any information as to the life-history of the invisible parasite it is impossible to correlate this resistance with any special growth form.

The invisibility of the organism sets an upper limit to its size in accordance with the resolving powers of the microscope; experiments with bacterial filters, in view of their tendency to clog, do not permit a lower limit of size to be assigned with confidence, while, on the other hand, the way in which a mycetozoan plasmodium will filter through a cotton-wool plug, cleaning itself from ingested food particles in the process, suggests caution in considering passage through a filter a proof that the natural diameter of the organism is smaller than that of the pore of the filter.

Although a filterable virus was first demonstrated as a cause of disease in the case of the tobacco mosaic, plant pathology is not so far advanced in its study of the organism as human pathology.

One great difficulty is that the culture of the organism outside the plant has so far proved impossible; in this respect these are as confirmed pathogens as the well-known group of rust fungi. Some of the virus diseases, as potato leaf-roll, net necrosis of the tuber, etc., seem to propagate only within a special tissue, the phlœm. This is worthy of consideration when attempts are made to cultivate the organism on artificial media, as the phlœm is relatively alkaline in reaction and both cell walls and contents are probably very distinctive in chemical composition.

Many of these virus diseases are propagated by insects, and Dr. Butler discusses critically the evidence which has been brought forward to explain the greater success of transmission when the plant cuticle is pierced by the insect rather than by needle or knife. One interesting possibility is the need for a necessary part of the life cycle of the pathogen to be completed in the insect carrier, but more work is also required upon the natural healing of punctures caused by insects and by instruments. The manner in which some aphids are also alleged to puncture always in the neighbourhood of the phlœm also provides a very interesting problem for further observation and experiment.

One interesting result of this work is the considerable significance it gives to the aphis as a carrier of plant diseases. At the International Potato Conference held under the auspices of the Royal Horticultural Society in November 1921, Mr. A. D. Cotton pointed out how the recent work of Quanjer in Holland and Schultz and Folsom in the States emphasised the importance of the relative intensity of aphides and possibly other insects in the propagation of leaf-roll. This disease, which is of very great economic importance, seems to spread from plant to plant chiefly in districts where the aphis-attack is general early in the season. As a result, the disease is transmitted very extensively in the warmer English counties, while in the Northern Scottish counties its spread may be little or nil, coincident apparently with the relative absence or late development of aphis infestation. This is very suggestive in relation to the proved value of Scotch seed-potatoes, and this important problem alone, with the new light it throws upon the principles to follow in seed-selection, would justify the extensive exploitation of this comparatively new field of scientific investigation.

University and Educational Intelligence.

Aberdeen.—Mr. W. G. Mackinnon has been appointed assistant in geology in succession to Miss Margaret Smith, resigned.

Liverpool.—On March 2 a new building comprising five chemical laboratories was opened by Lord Haldane as an extension of the University. Three floors are devoted to inorganic and two to organic chemistry, with extensive provision for research work. The building forms part of a scheme outlined before the War, which will require a further sum of 175,000*l.* for completion.

London.—The following doctorates have been awarded:—*Ph.D. in Science*: Mr. R. J. Ortlepp, of the London School of Tropical Medicine, for a thesis entitled "Studies on Helminthes Parasitic in Terrestrial Vertebrates," and Miss W. A. Leyshon, an external student, for a thesis entitled "Forced Oscillations in Self-maintained Oscillating Circuits."

A number of free public lectures and courses of lectures by distinguished men of science has been arranged for this term. At University College, Sir Thomas Holland will deliver three lectures on "Phases of Indian Geology"; Prof. G. N. Lewis, professor of chemistry in the University of California, three lectures on "The Structure and Behaviour of the Molecule"; and the following lectures by well-known Dutch scientific workers: "The Electric Charge of Colloids," by Prof. H. R. Kruyt, professor of organic chemistry in the University of Utrecht, on May 8; "The Rotation of the Earth and its Influence on Optical Phenomena," by Prof. H. A. Lorentz, professor of physics in the University of Haarlem, on May 17, in addition to a course of three lectures, commencing June 4, on "Problems in Relativity." Other lectures at University College include three by Mr. W. Macnab on "Some Scientific Principles of Chemical Industry," three by Prof. G. Dawes Hicks on "Kant's Theory of Beauty and Sublimity," one by Prof. C. Spearman on May 25 on "Psychology as a Career," and one by Prof. W. M. Flinders Petrie on May 17 on "Recent Discoveries in Egypt."

At King's College, there is a course of three lectures, on "Ethics and the Philosophy of History," prepared by the late Prof. E. Troeltsch, professor of philosophy in the University of Berlin; and four lectures on the tercentenary of the birth of Blaise Pascal by Prof. H. Wildon Carr.

Other lectures arranged under the auspices of the University are: three lectures by Dr. P. Giles at the School of Oriental Studies on "The Aryans," and a lecture, on May 7, at the Imperial College of Science, by Prof. W. de Sitter, professor of astronomy in the University of Leyden, on "Problems of Fundamental Astronomy."

Notice of the lectures will be given from week to week under the heading "Public Lectures" in Nature.

It is stated in the *British Medical Journal* that Dr. J. S. Anderson has been appointed to the chair of medicine at the University of Hong Kong. Dr. Anderson had a distinguished career at the University of Glasgow, and afterwards joined the staff of the Helminthological Department of the London School of Tropical Medicine.

A preliminary announcement has been issued regarding the University of Geneva Summer School to be held on July 16–September 1. In addition to the usual courses in modern French language and literature and lectures on current international problems (including the projects and achievements of the League of Nations, the International Labour Office, the Red Cross, etc.), there will be, for advanced students only, laboratory and field work in botany under the direction of Prof. Chodat at La Linnea (altitude 5600 feet) in the Mont Blanc district, and field geology and mountain climbing under the direction of Prof. Collet in the Mont Blanc, Jungfrau, and Matterhorn regions. Among the lecturers at the Summer School last year were professors of the Universities of Geneva, Paris, Bonn, Vienna, Christiania, Turin, and Washington, and of Dartmouth College (U.S.A.). Detailed information can be obtained from the Swiss Legation.

Prof. E. W. Scripture, formerly of Yale University and latterly engaged in carrying out investigations in London, has been appointed honorary professor of experimental phonetics in the University of Vienna. The appointment is significant alike of the growing importance of the subject, of the revival of this University after the devastation caused by the War, and of the movement discernible in the universities of the world as a whole towards such an interpenetration in disregard of international boundaries as was characteristic of the universities of the middle ages. Prof. Scripture was one of the pupils of the Abbé Rousselot, who was a pioneer in a field of knowledge the scientific exploration of which had scarcely been attempted when the Abbé began his researches thirty years ago. Recently it has yielded results of such immediately practical importance that it is receiving greatly increased attention. Prof. Scripture himself claims to have discovered that phonetics provides an efficient means of diagnosing earlier than would otherwise be possible, and thereby giving opportunities for the application of curative treatment to, general paralysis and disseminated sclerosis; also that the study of speech records of epileptics points to a revision of the hitherto accepted theory of the essential nature of this disease.

We have received from the Universities Bureau of the British Empire a list of students from the King's Dominions Overseas and from foreign countries enrolled for the current session in universities and university colleges of the United Kingdom. It affords material for some interesting statistical comparisons. The total number, 4131, shows a decrease of 8 per cent. compared with the total for the previous session (1921–22). In the following analysis showing the numbers of students from the several continents and countries, the corresponding figures for 1921–22 are given in brackets wherever markedly different: Africa 1171, America 764, Asia 1401 (1576), Europe 542 (645), Australia and New Zealand 250 (280); Egypt 298, including 67 at Birmingham and 81 at London; South Africa and Rhodesia 303, including 82 at Oxford, 43 at Cambridge, 336 at London, 142 (178) at Edinburgh, and 76 (95) at Dublin; Canada and Newfoundland 157 (200), including 60 (87) at Oxford; South America 73; U.S.A. 402, including 224 at Oxford; West Indies and Bermuda 120; China 119 (143); India, Burma, and Ceylon, 1094 (1240), including 175 at Cambridge, 335 (446) at London, 150 (170) at Oxford, 137 (173) at Edinburgh, 101 (65) at Glasgow; Japan 51 (73), France 52, Russia 91, Switzerland 43 (61), other countries of Europe 356 (431). In Nature, March 3, p. 308, we gave similar statistics regarding students in the United States and in Switzerland.

Societies and Academies.

London.

British Mycological Society, March 17.—A. S. **Horne** and H. S. **Williamson**: The morphological and physiological characteristics of two new species of Eidamia were described and compared with those of *E. acremonioides*, the only species previously included in the genus. One species obtained from oak wood is strongly acidophile and causes coloration of the wood; the other, isolated from decaying apples, is capable of causing rot in Bramley's seedling apple when kept under ordinary storage conditions or at a constant temperature of 1° C.—M. H. **Carré** and A. S. **Horne**: Various fungi were grown in soluble pectin of a high degree of purity extracted from apples. Certain fungi utilise the pectin with production of acidity (Botrytis, *Diplodia cacaoicola*), others break it down completely with the production of sugar (Eidamia from apple), while some are apparently incapable of growth in pectin.—A. S. **Horne** and H. M. **Judd**: The Eidamia from apple grown in sugar solutions exhibits different reactions according to the sugar used, as evidenced by the odour (of coconut oil), liquid coloration, and rate of growth (on plates). The reactions appear to show a definite relation to the configuration of the sugars concerned.—H. S. **Williamson**: The species of Eidamia from oak caused the production of a yellow colour in seasoned wood. This colour was reproduced when normal oak was inoculated with conidia of the fungus, and was found to be partly due to the colour of the conidia and partly to a yellow refractive substance produced in the metabolism of the fungus and accumulated in some of the cells of the wood.—J. S. **Bayliss Elliott** and O. P. **Stansfield**: The life history of *Polythrincium Trifolii*. The Hyphomycete stage is followed by a pycnidial stage. After the pycnidial stage reaches maturity the clover leaves wither. It was found possible to obtain further development by placing the leaves between glass cover-slips placed between ivy leaves buried in soil in plant pots in the open. The perfect form is not a species of Phyllachora as has usually been supposed, but Dothidella.—J. **Ramsbottom**: The correspondence between M. J. Berkeley and C. E. Broome preserved in the National Herbarium covers a period of more than forty years, and gives a clear idea of the way in which the collaboration between the two was carried on. It contains a mass of biographical detail, particularly of Berkeley, and gives a much better picture of the "Father of British Mycology" than do the meagre and misleading biographies which have so far been published. —P. J. **Alexander**: The dates of appearance and habitats of the Mycetozoa of Surrey. No month is without a representative, and three-quarters of the British species have been recorded for the county.

Association of Economic Biologists, March 23.—Prof. E. B. Poulton, president, in the chair.—J. H. **Priestley**: The causal anatomy of the potato tuber. The potato haulm is angular with three leafy expansions rising from the angles; a primary endodermis in the underground stem disappears in the region where the leafy angles appear. The circular, unwinged stem formation is a result of growth in darkness. The formation of the tuber at the end of the stolon coincides with the disappearance of the endodermis and the appearance of cork in the epidermal or subepidermal layer. The increase of tissue in the tuber is due to the meristematic activity both in the cortex and in the periphery of the pith. Earthing up potatoes may increase the stem area from which tuberiferous stolons may arise, and adequate moisture in spring with consequent vigorous root pressure may favour the formation of stolons; tubers may be expected to arise upon the stolons when the evaporation of water from the leaves exceeds water supply from the roots.—E. R. **Speyer** and O. **Owen**: The action of simple aromatic compounds on the cucumber woodlouse (*Armadillidium speyeri*, Jackson). Observations were made on the effects due to contact, vapour, and mixing with the soil at a concentration on M./100 in 250 gm. of soil; *p*-cresol and *p*-nitrophenol are less active than the corresponding ortho compounds, and both nitrophenols are less active than phenol. One part phenol in 750 parts soil is sufficient to kill all woodlice introduced during a period of 20 days, and this time corresponds with the disappearance of retardation in germination of tomato seeds sown in the same soil. Phenol and the cresols were the most active compounds tested; naphthalene disappears within 4 days of mixing with soil; thymol, camphor, hydroquinone, and α-naphthol act slowly.

Royal Microscopical Society (Industrial Applications Section), March 28.—Mr. J. Leonard Spicer in the chair.—S. R. **Wycherley**: Microscopy in the examination of manufactured paper. Paper is composed of disintegrated vegetable fibres, their length, strength, and breadth giving colour and durability. Linen fibres give the strongest and toughest of papers, and in their natural condition are tapered at the ends. The fibres have nodes which often burst, and then the fibres curl over and the hooks entangle one with the other, knitting together. Tested with Herzberg solution the result is brown coloration; with zinc chloride solution, claret coloration. Cotton fibres, the main constituent of high-class writing papers, are even and round with a number of twists along the whole length. Wood fibres are merely fibres of wood crushed or reduced to pulp: chemical wood-pulp fibres are always longer and cleaner than those of mechanical wood pulp. The fibres are distinguished by their bordered pits; they give a low-grade paper. Esparto fibres are long, thin, and smooth with a narrow canal, and there is always a residue of seed hairs. A microscope will often show whether the fibres have been too severely treated by the beaters, and also whether a heavy proportion of re-pulped paper has been used.—J. **Strachan**: The manufacture of papers for wrapping and containing food-stuffs. Legislation is required specifying the proper wrapping for particular foods. Papers for this purpose are classified as follows: Food-holders, such as the paper wrapper and the paper container; food-carriers, such as the box, the carton, and the fibre-board packing-case. The paper bag is used both as holder and carrier. The most important class of paper is that used in direct contact with the food-stuff. The basic paper for this should be a pure bleached cellulose, sterilised during the process of manufacture. Chemical and physical treatment of this base gives a variety of papers for specific purposes, such as the exclusion of colloids, moisture, and gases, or the retention of oily matter and flavours.—H. B. **Wrighton**: Objectives for metallurgy. The mounts should be of a metal which will resist the strongly acid atmosphere present in laboratories where analytical work on metals is carried out, and the front lenses should be protected against damage by accidental contact with metallic specimens. Glasses and cements used must be of a permanent character, as considerable heat is developed by the intense light used in the photomicrography of metal specimens. The most suitable balance among the various optical corrections differs somewhat from the one generally accepted for the other branches of microscopy; in particular, flare should be reduced to the absolute minimum. The requirements of metallurgical microscopy are sufficiently distinct to justify the production of objectives computed and designed specially for this work.

Paris.

Academy of Sciences, March 26.—M. G. Bigourdan in the chair.—R. de **Forcrand**: Thallium hydroxide. The usual method of preparing thallium hydroxide by precipitation of the sulphate with baryta is very tedious, and liable to give an impure product. A better method is to treat thallium ethylate, $C_2H_5 . OTl$, with water and starting with TlOH and Tl_2O prepared in this way, the thermochemical constants have been redetermined.—M. **Soula**: Taylor's series having an infinity of zero coefficients.—P. **Noaillon**: A harmonic function the gradient of which vanishes at infinity.—Henri **Chrétien**: Recording time, in figures, to the thousandth of a second, with an electrically maintained pendulum. A description, with illustrations, of a new recording chronograph of simple construction.—G. E. **Beggs**: The exact solution of problems indeterminate statically by means of paper models.—M. **Lafay**: The possible use of the microphone to facilitate problems of flight.—J. **Trousset**: Can the observation of the planets furnish arguments for or against relativity? The author gives reasons for answering this question in the negative.—Paul **Mondain-Monval**: The variation of heats of solution with temperature. Details of experiments on heats of solution of potassium, sodium, and ammonium nitrates, potassium sulphate, and ammonium and potassium chlorides at 0° and 18° C.—Th. **Tommasina**: Contribution to the dynamo-kinetic theory of the electron and the atom.—Georges **Déjardin**: The critical velocities of the electrons in krypton and the production of the spectra of this gas. An account of work done with a three electrode tube of an improved type. The ionisation potentials of argon and krypton were found to be $15 \cdot 2 \pm 0 \cdot 2$ volts and $12 \cdot 7 \pm 0 \cdot 2$ volts respectively: the double ionisation potentials were 34·0 volts and 28·25 volts. Krypton, like argon, gives two spectra, details of which are given.—Albert **Portevin**: The variations of capacity accompanying the thermal treatment of hollow steel bodies. Study of the influence of the tempering temperature, rate of cooling, and hardness of steel on the changes of capacity of steel shells.—L. J. **Simon** and M. **Fréjacques**: The methylating and sulphonating action of methyl sulphate on phenols in the absence of water. This reaction is very complicated. With phenol at least eight substances are present: methyl ether, anisol, phenol and anisol sulphonic acids and their methyl esters, and methylsulphuric acid. The methods of separation are given.—A. **Mailhe**: A new preparation of the tetrasubstituted ureas. The formamide of methylaniline, $C_6H_5 . N(CH_3)(COH)$, passed as vapour over finely divided nickel at 380°-400° C. gives symmetrical dimethyl-diphenylurea, $CO(N(CH_3)(C_6H_5))_2$. That the method is of general application is proved by other examples.—F. **Bordas** and T. **Touplain**: The denaturation of ethyl alcohol. The use of alcohol as a constituent of a motor fuel requires a cheaper denaturant, and one easily detected. The use of methyl or ethyl borate is suggested.—P. **Gaubert**: The liquid crystals of anisal-*p*-amidoazotoluene. A reply to some criticisms of G. Friedel.—M. **Solignac**: The tectonic of the plain of Mateur and its approaches (Tunis).—F. **Baldet**: Contribution to the study of atmospherics. A method of searching for and partially eliminating low frequency parasitic currents of atmospheric or telluric origin.—Pierre **Dangeard**: The vacuome in the pollen grains of Gymnosperms. Application of the vital coloration method (neutral red) to the study of the pollen grains of *Taxus baccata*, *Cephalotaxus Fortunei*, *Cupressus Lawsonia*, and *Pinus Armandi*.—Mlle. France **Gueylard**: Intervention of the spleen in the phenomena of adaptation to changes in salinity. It is known that *Gasterosteus aculeatus* can be transferred from fresh to salt water, and rapidly adapts itself to the change of medium. It is shown that change in the salinity of the medium results in changes in the spleen, the higher the proportion of salt in the water, the greater the reduction in the proportional weight of the spleen.—Marcel **Duval** and P. **Portier**: The impermeability to urea of certain tissues of selacian fishes.—Jules **Amar**: The law of vivireaction in biology and pathology. This law is stated thus: any pathological or physico-chemical act which tends to reduce the phenomena of organic oxidation provokes, by a defence mechanism, a relative increase of the pulmonary ventilation.—L. M. **Betances**: The specific differentiation of the hematic cell in the Metazoa.—André **Lwoff**: The nutrition of the Infusoria. Although, under natural conditions, the nutrition of free infusoria is purely phagocytic, it is possible, in a suitable medium, to feed some species by means of dissolved substances.—Boris **Ephrussi** and André **Lwoff**: The double cyclic periodicity of the zone of division in *Colpidium colpoda*.

Washington.

National Academy of Sciences (Proc. Vol. 9, No. 1, January).—H. W. **Brinkmann**: On Riemann spaces conformal to Euclidean space. An n-dimensional Riemann space can be "imbedded" in an $(n+2)$-dimensional Euclidean space.—O. **Veblen**: Equiaffine geometry of paths. A definition of volume which generalises that used in Riemann geometry is derived.—L. P. **Eisenhart**: Affine geometries of paths possessing an invariant integral.—J. R. **Kline**: Closed connected sets which are disconnected by the removal of a finite number of points.—R. S. **Woodward**: Some extensions in the mathematics of hydromechanics. A development of some of the equations used to describe fluid motion when viscosity is taken into account.—P. D. **McMaster** and P. **Rous**: Hydrohepatosis, a condition analogous to hydronephrosis. Prolonged obstruction of the bile duct in dogs causes distention of the duct and of the gall-bladder with "white-bile," a colourless, watery fluid. A pressure obstacle causes reduction in total secretion and in the percentage output of some of the substances secreted, as in kidney obstruction, though the distention caused is less marked.—H. **Laugier** and R. **Legendre**: Novocaine and curarisation. Novocaine causes morphological changes in nerve fibre, and a solution (1 in 10,000) in physiological salt solution causes an increase in the intensity of a suddenly established current necessary to provoke visible muscular contraction, and decreases the interval before response occurs.—F. G. **Benedict** and E. G. **Ritzman**: Under-nutrition and its influence on the metabolic plane of steers. Eleven adult steers were fed for about 4½ months on one-half their original maintenance ration. Changes in body tissue were measured by the carbon dioxide output, using a respiration chamber. At first there was rapid reduction in live-weight, due to changes in intestinal ballast or fill; afterwards there was slow steady loss, due to drafts on body material; and during the last few weeks the weights were practically constant. The animals remained active, but the pulse dropped from 44 to about 28. Maintenance level of metabolism in control beasts was 2150 calories per 24 hours per square metre of body surface; for the underfed animals it was 1475. On refeeding, the animals rapidly regained weight and were readily fattened. The energy value of the fæces remained practically constant at 4·778 calories per gm. of water-free substance under all feeding conditions.—C. G. **Darwin**: A quantum theory of optical dispersion (see Nature, December 23, 1922, p. 841).—W. H. **Cole**: Circus movements of Limulus. The animals were subjected to diffuse and non-directive illumination, and only one lateral eye was allowed to function. In accordance with Loeb's tropism theory, the diameter of the circles traced out was inversely proportional to the intensity of the light.

(Proc. Vol. 9, No. 2, February).—R. W. G. **Wyckoff**: On the hypothesis of constant atomic radii. Starting from cæsium dichloro-iodide, values have been calculated for the "spheres of influence" or atomic radii of several atoms. These values are compared with the corresponding observed interatomic distances. Many discrepancies occur, showing that it is not in accord with experiment to assign a definite size to each atom. In some groups of isomorphous compounds composed of two kinds of atoms a law of constant atomic radii appears to hold. In compounds of different crystal structure, in which the manner of arrangement of the atoms of one kind about those of another (atomic environment) is different, the interatomic distances are unlike.—A. Van **Maanen**: Photographic determination of parallaxes with the 100-inch reflector (Mount Wilson). Four fields have been measured, including the helical nebula (N.G.C. 7293). Using the parallax derived, +0·058, the object appears to have a diameter 375 times that of the solar system.—H. **Shapley**: Light and colour variations of Nova Aquilæ 1918.4. The nova was a star (10-11 mag.) at least 30 years before its discovery. Rise in brightness began on June 7, 1918, reached a maximum, at visual magnitude −1·2, in two days, when it was brighter than any star in the sky except Sirius, and decreased four magnitudes by June 25. Semi-periodic fluctuations occurred until October, with decreasing brightness, and since then it has continued to decrease until it is now about magnitude 10.—E. H. **Hall**: A theory of the Hall effect and the related effect for several metals. When a magnetic field acts at right angles to a current flowing along a thin strip of metal, the equipotential lines are no longer at right angles to the line of flow (Hall effect) and a transverse temperature gradient is set up (Ettingshausen effect). Analogous effects are obtained if heat is flowing along the strip. The explanation offered assumes that conduction implies the existence of two streams, one of free electrons and the other of associated electrons, which oppose each other.—F. B. **Sumner**: Studies of sub-specific hybrids in Peromyscus. Three different crosses between geographic races of deermice were studied in respect of 17 quantitative characters. The mean values for any character in the hybrid is usually between the parental values. Means for the two hybrid generations (F_1 and F_2) generally agree. There appears to be a tendency towards increase of variability which is not due to environmental factors. Most of the elements of the total sub-specific complex seem independent of each other in inheritance, and no single character behaves in obvious Mendelian fashion.—G. A. **Miller**: Sets of conjugate cycles of a substitution group.—A. **Carrel**: Leucocytic secretions. Evidence was obtained of the production of substances promoting growth of homologous fibroblasts and destroying foreign erythrocytes, both *in vitro* and *in vivo*. This supports Renaut's view that the function of the white corpuscles of the blood is to bring nutritive substances to the fixed cells of the tissues, and it also appears that they can bring regenerative substances to injured adult tissue. A foreign protein added to leucocytic cultures increases the production of growth-activating substances; *in vivo* this may precede the production of anti-bodies.—W. M. **Davis**: Drowned coral reefs south of Japan. Some of the Riu Kiu and Bonin Islands are on the margin of the coral seas of to-day; they have no regular sea-level reefs, though their shore-lines resemble those of the embayed islands of the coral seas. The islands may have been protected by reefs while suffering erosion during a period of greater emergence followed by relatively slow submergence. Continued upward growth of the protecting reefs has possibly been inhibited by decrease of ocean surface temperature. A temperature high enough for the growth of the suggested coral reefs may have been caused by the deflexion of the North Equatorial current of the Pacific when the ocean surface was lowered during the Glacial epochs.

Calcutta.

Asiatic Society of Bengal, March 7.—Lily **Strickland-Anderson**: Music and the Hindu Pantheon. An attempt to apply the principle that Hindu mythology represents a kinetic or fluidic and not a static or concrete mode of thinking, to the Hindu Pantheon, specially relating to music.—K. G. **Sinha**: On some Maithili dramas of the seventeenth and eighteenth centuries. An attempt is made to explain the nature and importance of the dramas as throwing light on the development of Mithilā art and culture.—C. V. **Raman**: (1) A theory of the viscosity of liquids. An attempt is made to calculate the viscosity of liquids theoretically on the basis of the molecular hypothesis. (2) The molecular ælotropy of liquids. The optical anisotropy of the molecules evidenced by experiments on the scattering of light is discussed, and an attempt is made to find how the molecules influence each other's position and orientation.—N. **Annandale**: Bivalve molluscs injuring brickwork in the Calcutta docks. A note on injury done to brickwork by the boring mollusc *Martesia fluminalis* and on other molluscs associated with it.—P. **Brühl** and K. **Biswas**: On a new species of Cylindrospermum from Bengal. Description of a new species, *Cylindrospermum doryphorum, sp. nova*, Brühl et Biswas. Comparison with known species.—L. Dudley **Stamp** and L. **Lord**: A preliminary note on the ecology of part of the riverine tract of Burma. The area dealt with embraces a zone of country on either bank of the Irrawaddy river between Prome and Yenangyaung, which covers more than 4000 square miles. The inter-relationships existing between the geological formations, soils, climate, and the distribution of the vegetation are traced in detail. The plant formations are classified into 13 groups and the investigation revealed that climate, especially rainfall, is really the main determining factor in the development of any particular type of vegetation within this region.—S. L. **Hora**: Zoological results of a tour in the Far East. (Fish, Part I.) The first part of a report on a collection of fish from a maritime lagoon connected with the Gulf of Siam which contains water of very variable salinity. Forty-eight species of the Selachii and of seven teleostean orders are discussed. A new species of pipe-fish, and one of Mastacembelus, are described and also a new colour form of *M. armatus*.—B. Prashad: Revision of Kobelt's nomenclature of the Indian Ampullariidæ.

Official Publications Received.

South Australia: Department of Mines. Mining Review for the Half-Year ended 30th June 1922. Compiled by Lionel C. E. Gee. Pp. 64. (Adelaide.)

South Australia. Annual Report of the Director of Mines and Government Geologist for 1921. Pp. 10+2 maps. (Adelaide.)

The Carnegie United Kingdom Trust. Ninth Annual Report (for the Year ending 31st December 1922) submitted by the Executive Committee to the Trustees on Friday, 9th March 1923. Pp. xii+63. (Edinburgh.)

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 52, July to December 1922. Pp. vi.+151-324+12. (London: Royal Anthropological Institute.) 15s. net.

Ministry of Public Works, Egypt. Report on the Work of the Physical Department for the Year ending 31st March 1922. By Dr. H. E. Hurst. Pp. 22. (Cairo: Government Printing Office.) P.T. 5.

Regenwaarnemingen in Nederlandsch-Indië. Twee en Veertigste Jaargang, 1920. Pp. vi+123. Drie en Veertigste Jaargang, 1921. Pp. iii+123. (Weltevreden, Java: Landsdrukkerij.)

Annual Reports: The Academy of Natural Sciences of Philadelphia for the Year ending 30th November 1921. Pp. 74. (Philadelphia.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 74, 1922. Pp. iii+313+22 plates. (Philadelphia.)

Annals of the Missouri Botanical Garden. Vol. 9, No. 3, September. Pp. 233-332. (St. Louis, Mo.) 1 dollar.

Library of Congress. Report of the Librarian of Congress and Report of the Superintendent of the Library Building and Grounds for the Fiscal Year ending 30th June 1922. Pp. 209. (Washington: Government Printing Office.) 50 cents.

Diary of Societies.

MONDAY, APRIL 23.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. D. Anderson-Berry: Occultism: at the Bar of Philosophy and Religion.

ROYAL SOCIETY OF MEDICINE (General Meeting), at 5.—Sir Archibald Garrod, Dr. F. J. Poynton, Dr. M. Cassidy, and Dr. A. F. Hurst: Discussion on The Ætiology and Treatment of Osteo-arthritis and Rheumatoid Arthritis.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Syphilis.

INSTITUTION OF MECHANICAL ENGINEERS (London Graduates' Section), at 7.—S. H. G. Warne: Recent Steam-Wagon Progress, and a Suggested Design.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. H. Shaughnessy and others: Discussion on Practical Broadcasting.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—W. G. Newton: The Literature of Architecture.

ROYAL SOCIETY OF ARTS, at 8.—E. Kilburn Scott: Nitrates from Air (3). (Cantor Lectures.)

FARADAY SOCIETY (at Chemical Society), at 8.—J. H. Shaxby and J. C. Evans: The Properties of Powders—The Variation of Pressure with Depth in Columns of Powders.—E. E. Walker: The Properties of Powders. Part VI. The Compressibility of Powders. Part VII. The Distribution of Densities in Columns of Compressed Powder.—E. K. Rideal: The Rate of Hydrogenation of Cinnamic and Phenylpropiolic Acids.—A. Taffel: The Temperature of Maximum Density of Aqueous Solutions.—L. Anderson: Note on the Coagulation of Milk by Acid.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Dr. C. F. Sonntag: Some Points in the Comparative Anatomy of the Mouth and Tongue.—G. J. Harborow: A Case of Unerupted Incisors and Canines in a Male aged 59.—E. Sprawson: The Vascular Supply of the Enamel Organ of *Felis domesticas*.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—L. M. D. Buxton: Inner Mongolia.

TUESDAY, APRIL 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: The Machinery of Human Evolution (3). How New Features are Gained.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. C. Gouldesbrough: Osteo-arthritis of the Spine.—Dr. H. L. Tidy: Glandular Fever and Infective Mononucleosis.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—R. B. Murray: Exhibition of a Giant Centipede from Trinidad, and Mounted Skins of Oil-birds.—Lt.-Col. S. Monckton Copeman and Major E. E. Austen: Exhibition (with photographs) of a unique British Dipteron, taken on Primrose Hill.—Baron F. Nopcsa: The Origin of Flight in Birds.—E. C. Stuart Baker: Cuckoos' Eggs and Evolution.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—Capt. J. W. Bampfylde: Photomicrography as applied to the Iron-Carbon.

WEDNESDAY, APRIL 25.

ROYAL SOCIETY OF ARTS, at 4.30.—Conference on the Milk Question.—Papers: Prof. R. S. Williams: The Arguments for maintaining an Open Market for Fresh Milk.—Prof. J. C. Drummond: Changes in the Digestibility and Nutritive Value of Milk induced by Heating.—Dr. S. S. Zilva: The Effect of Heat on some Physiological Principles in Milk.—Capt. J. Golding and Mrs. A. T. R. Mattick: A Demonstration of some of the Chemical Changes in Milk on Heating to various Temperatures.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.—C. Baker: Junior Engineer Metallurgical Microscope and the Greenough Binocular Microscope.—R. and J. Beck, Ltd.: New Research Outfit for Metallurgical Work, including Microscope, Camera, Optical Bench, etc.—Edison Swan Electric Co., Ltd.: Projector and Fullolite Lamps.—M. P. Swift: Use of Dichroiscopes for the Identification of certain Gem Stones.—W. Watson and Sons, Ltd.: Petrological Microscopes.—At 8.—J. E. Barnard: The Manipulation of the Microscope in Industrial Laboratories. Part I. Illuminants and Illumination.—Dr. M. C. Stopes: The Microscopical Examination of Coal in relation to Fuel Economy and Efficiency.

BRITISH PSYCHOLOGICAL SOCIETY (Medical and Education Sections) (at London Day Training College), at 8.—Drs. East, Burt, Shrubsall, and Stoddart: Symposium on Delinquency and Mental Defect, to be followed by a discussion.

THURSDAY, APRIL 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. T. MacGregor-Morris: Modern Electric Lamps (1). Glowing Solids *in vacuo* (Tungsten Lamps).

ROYAL SOCIETY, at 4.30.—Prof. T. R. Merton and R. C. Johnson: Spectra associated with Carbon.—R. A. Watson Watt and Dr. E. V. Appleton: The Nature of Atmospherics.—Prof. W. A. Bone, D. M. Newitt, and D. T. A. Townend: Gaseous Combustion at High Pressures. Part III. The Energy-absorbing Function and Activation of Nitrogen in the Combustion of Carbon Monoxide.—Dr. I. Masson and L. G. F. Dolley: The Pressures of Gaseous Mixtures.—W. R. Bousfield and C. Elspeth Bousfield: Vapour Pressure and Density of Sodium Chloride Solutions.—Prof. F. A. Lindemann and G. M. B. Dobson: A Note on the Temperature of the Air at Great Heights.—Prof. G. H. Hardy and J. E. Littlewood: Lindelöf's Hypothesis concerning the Riemann Zeta-function.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Grace Chisholm Young: The Solution of a Pair of Diophantine Equations connected with the Nuptial Number of Plato.—H. W. Richmond: (1) The Electrostatic Field of a Plane Grating with Thick Rounded Bars; (2) Notes on the use of the Schwarz-Christoffel Transformation in Electrostatics.—E. G. C. Poole: The Discontinuous Motion produced in an Infinite Stream by Two Plane Obstacles.—A. E. Ingham: Two Mean Value Theorems concerning Riemann's Zeta-function.—A. E. Jolliffe: The Inflexions of the Non-singular Plane Quartic.—R. Vaidyanathaswami: Transversal Problems in Hyperspace.—T. Stuart: Certain Diophantine Equations.—M. Riesz: Sur l'équivalence des certaines méthodes de sommation.—K. Basu: The Perturbations of the Orbit of the Valency-electron in the Generalised Hydrogen-unlike Atom.—Pandit Oudh Upadhyaya: Cyclotomic Heptasection.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 5.30.—Annual General Meeting.—At 6.—Dr. W. G. Sleight: Children's Taste in Pictures.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. Breach and H. Midgley: The Drive of Power Station Auxiliaries.

SOCIETY OF DYERS AND COLOURISTS (London Section) (at Dyers' Hall, Dowgate Hill), at 7.—L. G. Lawrie: Fur Dyeing.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30—Clinical and Pathological Evening.

FRIDAY, APRIL 27.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botany Theatre, Imperial College of Science and Technology), at 2.30.—Dr. C. M. Wenyon: Some Recent Observations on Pathogenic Protozoa of Plants and Animals.—(To be followed by a discussion.)

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—(Epidemiology and State Medicine Section), at 8.—Dr. T. F. Dewar: The Incidence of Venereal Disease in Scotland.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—The Research Staff, General Electric Co., Ltd.: The Analysis of Bubbles in Glass.—Dr. H. P. Waran: A Simple Regenerative Vacuum Device, and some of its Applications.—Capt. H. Shaw and E. Lancaster Jones: Application of the Eötvös Torsion Balance to the Investigation of Local Gravitational Fields.—L. F. Richardson: Demonstration of an Electromagnetic Inductor.—Dr. F. Ll. Hopwood: Demonstration of Experiment Illustrating Time-Lag in Vision.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Surgical Anatomy of the Foot.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Adjourned Discussion on paper by A. E. L. Chorlton: The Use of Light Alloys in place of Iron and Steel.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. Feard: Stock Control.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—A. Watkins: Early British Trackways.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. C. V. Boys: Measurement of the Heating Value of Gas.

SATURDAY, APRIL 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. L. L. B. Williams: The Physical and Physiological Foundations of Character (1).

PUBLIC LECTURE.

WEDNESDAY, APRIL 25.

KING'S COLLEGE, at 5.30.—The late Prof. E. Troeltsch (by Dr. E. Barker): Ethics and the Philosophy of History. (Succeeding lectures on May 2 and 9.)

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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Education and Science in the Civil Service Estimates.

THE provision for Education, Science, and Art for the year ending March 31, 1924, in the Civil Service Estimates continues to show reductions upon previous years. Excluding Ireland, the expenditure under these heads was 61,675,301*l.* in 1921–22 and 54,150,207*l.* in 1922–23. For 1923–24 the estimate is 49,902,435*l.*—a sum which is less than the actual expenditure of 1921–22 by 11,772,866*l.* This is an enormous reduction, and however serious the economic situation—and one must grant that the financial stringency is still great—such a reduction cannot be viewed with unconcern by those who have the real interest of the country at heart.

It should be noted, however, that the estimates under review include expenditure other than that upon school education. They include the cost of national museums and art galleries, as well as grants to scientific and industrial research, and to universities and institutions of university rank. The Board of Education estimate is 41,934,047*l.*, a decrease of 3,340,953*l.*; while the estimate of the Scottish Education Department is 5,922,995*l.*, a decrease of 869,379*l.* These two reductions together make up the major portion of the proposed reduction of 4,247,772*l.* for the current financial year.

It will be instructive to examine in more detail some of the proposed expenditure. In the Board of Education estimates the grant for elementary education is put down at 33,069,100*l.*, a reduction on last year of 1,999,693*l.* and on 1921–22 of 3,929,613*l.* One is moved to remark that if a reduction in this grant of almost four millions in two years can be made without detriment to the future efficiency of the nation, there must have been something radically unsound in the distribution of these grants in the past. If, however, the future efficiency is seriously threatened by such a reduction, then an apparent economy may well turn out to be a real extravagance. Again, the estimate for the grant for higher education is 7,315,520*l.*, which means a reduction of 707,055*l.* on last year's grant, or of 1,462,910*l.* on that for 1921–22. It is clear that the reductions in the grants for higher education are proportionately much greater than for elementary education and may well have serious consequences. In particular, it would be difficult to justify the reduction of 4000*l.* for technical colleges—and this in addition to a reduction of 10,000*l.* in the previous year—and that of 123,725*l.* for the training of teachers. On the other hand, it was to be expected that the grant for the higher education of ex-Service officers and men should automatically decrease. Accordingly, 310,000*l.* is estimated as compared with 1,015,000*l.* last year, with a corresponding reduction of 7283*l.* in cost of administration of this grant.

So far as the administrative staff of the Board of Education is concerned, there seems to be little reduction in numbers. Apparently the reduction in the cost of this service will depend mainly upon the fall in the index figure of the cost of living, since the bonuses on salaries are made with reference to it. One would think that in view of the extensive reductions in the grants to elementary and higher education, the estimate of 356,982*l.* for inspection and examination, notwithstanding a reduction of 26,061*l.*, is higher than necessary, and could be further reduced without serious detriment. With one important exception, reductions have been the rule rather than the exception; the estimate for pensions to teachers is 2,400,000*l.*, as against 1,860,000*l.* last year. This increase of 540,000*l.* was expected, and no doubt will be exceeded next year. With regard to this, of course, one must take into consideration the contribution of 5 per cent. of the teachers' salaries.

Under the head of Aid to Students, further reductions are noticeable. Last year there was a reduction of 4500*l.* in the sum allowed for scholarships, studentships, and exhibitions tenable at universities; this year there is a further reduction of 2000*l.* Similarly for students at training colleges the total estimate for this year is 119,170*l.*, as compared with 137,095*l.* last year. The total reduction in the grant in aid of students is 19,982*l.*, and this comes as a further reduction upon a drop of 10,213*l.* last year. One cannot but feel uneasy at the withdrawal of 30,195*l.* in two years from a class of students, presumably deserving, but unable to afford the cost of a higher education.

The estimates contain some interesting "Notes" as to the further measures proposed for keeping down the cost of education. The Board of Education defines its attitude regarding the expenditure of local education authorities which will be recognised for purposes of grant. In 1922–23 this expenditure was not to exceed 62,450,000*l.* A later revision fixed the sum at 60,595,000*l.* This year the amount is limited to 58,902,000*l.*, and of this total not more than 300,000*l.* may be spent on the provision of meals. Higher education fares no better. The total expenditure by the local education authorities to be recognised by the Board of Education for 1923–24 must not exceed 12,160,000*l.*, as compared with 13,000,000*l.* in 1922–23. This year, too, a clause is inserted in the Notes to the effect that the number of students recognised for grant under the Regulations for the Training of Teachers during the financial year 1923–24 is expected to be 12,066, as compared with 12,640 in 1922–23. This reduction, it may be stated, is not due to a lack of candidates coming forward, but to the policy adopted by the Board of reducing the number of those in training.

Turning now to the votes under the Treasury, we find that there are still further reductions. After the reduction of 19,157*l.* last year in the grant for scientific investigation, it is a little disquieting to find a further decrease of 1303*l.* this year. Similarly, the drastic reduction of 118,486*l.* last year in the vote for scientific and industrial research has been followed this year by the proposal of a further net reduction of 20,574*l.* It will be unfortunate if this reduction should hinder the progress of scientific research at a time when such research is most urgently needed. The grant in aid of universities and colleges is estimated at 1,169,000*l.*, which is the same as last year. It will be remembered that in 1921–22 the grant from the Exchequer for the university institutions of the United Kingdom was 1,500,000*l.* Although the present estimate is only for university institutions in Great Britain, the reduction for these bodies this year will be little short of 250,000*l.* At the same time it should be noted that other institutions (in particular, Oxford and Cambridge) and certain clinical units of the London Medical Schools have been since added to the list, and are now receiving substantial grants under this vote. It would seem that universities and colleges as a whole have been badly hit by the economies of the last two years. One can readily understand why those who believe in education, and particularly in higher education, are viewing with grave concern the present position. It would be little short of a national calamity if the opportunities for research or the development of university education in this country were to be restricted at the very time when they should be fostered and encouraged.

Weights and Measures, with some Geophysics.

A Dictionary of Applied Physics. Edited by Sir Richard Glazebrook. In 5 volumes. Vol. 3: Meteorology, Metrology, and Measuring Apparatus. Pp. vii + 839. (London: Macmillan and Co., Ltd., 1923.) 63*s.* net.

IT would be difficult to over-estimate the value of the contents of this book, and our debt of gratitude to Sir Richard Glazebrook for having collected and edited the articles is very great indeed. A certain amount of the information contained is new, and practically the whole of the remainder is inaccessible to the ordinary student.

It is not easy to specify in a few words the subjects treated, and the sub-title—meteorology, metrology, and measuring apparatus—is not very helpful; in fact, it is difficult to understand why this title was chosen, except for its attractive alliteration, for it certainly would not lead us to expect articles on earthquakes, oceanography, radiation, and many other subjects which are not meteorology, or metrology, or measuring apparatus.

As a matter of fact, most of the subjects treated appear to fall into some such classification as the following:

Measurement.—Theory and practice of measurements of length, mass, time, and their derivatives; alcoholometry; saccharometry; drawing instruments; calculating instruments; combination of observations; and allied subjects.

Geophysics.—Form and mass of the earth; meteorology, including atmospheric electricity; oceanography; seismology and tides.

On the other hand, terrestrial magnetism, electrical and magnetic measurements, and thermometry are not treated in this volume.

One of the chief values of the articles lies in the fact that they are not compilations from text-books and scientific journals, but each is written by a man whose life is engaged on the work he describes. This is clearly seen from the following list of the institutions which have provided writers from their staffs, past or present. There are 43 main articles in the volume, of which 12 are provided by the National Physical Laboratory, 7 by the Meteorological Office, 2 each by the Royal Geographical Society and the Survey of India, 1 each by the Bureau of Standards, U.S.A., and the Ordnance Survey. The writers of the 18 remaining articles include such well-known names as Profs. Boys, Knott, Sampson, Skinner, and Turner; Sir Horace Darwin, and Mr. C. T. R. Wilson.

Before dealing with the articles themselves, it may be worth while to remark on a few points connected with the general arrangement of the book which have struck us very forcibly while reading the 800 or so pages of which it consists. The arrangement is obviously a compromise, and a compromise can never give entire satisfaction. It would appear that the first idea of the work was that of a dictionary with probably the alphabetic arrangement throughout, as in the "Encyclopædia Britannica." But that idea has been modified, and a series of volumes each dealing with more or less allied subjects has been adopted. We cannot be too grateful for this decision; for in these hard times a single volume may be within the means of many who could not afford the whole set. We cannot help regretting, however, that the whole dictionary idea was not abandoned at the same time. Whatever the intention may have been, the volume before us is practically a collection of 43 articles and an index to them; but instead of the latter being placed at the end, it is embodied by the dictionary method throughout the whole book, and the articles are strung on to it like large beads on a necklace. This method has two great drawbacks: in the first place, the long breaks in the sequence of the words, due to the interpolation of the long articles, make it difficult to turn up a word quickly. Then technical difficulties of printing have made it impossible to give references to pages, and the reader is referred to sections and paragraphs of the main articles, the title of the article being set out in full in each case. This entails a great deal of unnecessary printing, and it is not easy to find a specified paragraph, as the sections in some cases extend over several pages. A simple index with references to pages would have served the same purpose, and would not only have been easier to use but also probably have reduced the size of the volume by many pages, with great convenience to the reader and a reduction in the cost of printing.

While we are discussing the convenience of the reader, it may be as well to direct attention to the want of system with regard to references to literature. Some of the articles have very full references while others have practically none, but the method of making the references varies from article to article. In some the references are given in the text, in others in footnotes, while in a few they are collected together in a bibliography at the end of the article, the numbered items of which are indicated in the text by the use of numbers in brackets. In fact, this book reflects the chaos in general scientific literature in this matter. Nothing is more disturbing when reading a difficult article than to have the attention constantly distracted by frequent references to footnotes, some of which may be of importance to the argument, and therefore must be read, while others are only references to literature. For this reason it is surely desirable that there should be some distinction between the two kinds of references. The method which seems the most reasonable is to use figures in brackets in the text to connect with references to literature collected together at the end of the article—or chapter in the case of a text-book—while notes necessary to the argument should be given, if they cannot be avoided, at the foot of the page, and attention directed to them by an asterisk or other conventional sign used to indicate a footnote. In this way a reader would almost unconsciously pass over the literature references and yet never miss a footnote. The advantages of this method are so obvious when many references are given that it is surprising it is so little used.

There is still one more point of arrangement which affects the convenience of the reader. The articles in these volumes owe their outstanding value to the high authority of the authors, and it is unlikely that any one will consult an article without wishing to know who wrote it. He will look first at the beginning of the article, and not finding the name there he will probably turn to the end, where he will find the initials of the author. But it is very seldom that the initials of the best-known writers are familiar, so the reader has not yet got the information he requires. He may then recollect having seen a "List of Contributors" at the beginning of the book, and here he will finally find the name belonging to the initials. Why should not the name of the writer have been put at the commencement of each article, where the reader naturally turns to find it?

Returning now to the articles themselves, they are so numerous, and deal with so many subjects, that it is quite impossible to notice them all, so we must content ourselves with a few words on one or two of the most important.

In the group of articles dealing with measurement, the discussion of metrology by Mr. J. E. Sears, the Deputy Warden of the Standards, is of outstanding merit. Without going into a great deal of detail a clear account is given of the history of the British and metric standards of length, mass, and volume, followed by the theory of the methods used in comparing these standards with practical measuring apparatus. It will come as a surprise to most people to read in this article that two kilogram masses can be compared with a greater accuracy than two metre standards, the accuracy being one part in 10^8 and in 10^7 respectively. Mr. Sears's discussion of the relative advantages of the British and metric systems is very valuable, and clearly indicates that the advantages are not all on one side. He is strongly opposed to attempts to hurry a change in Great Britain, and concludes: "The only practical policy, and that which has actually been followed, is to give legal sanction to the *alternative* use of the metric system, and to trust to the processes of time to effect a gradual change. The efforts of those who desire to see the metric system in universal use would be more usefully employed in endeavouring to encourage and facilitate its voluntary adoption in this way, than in seeking to secure legal compulsion in advance of public desire."

This article on metrology is supplemented by separate articles dealing with the practical side of making measurements and comparing standards. These are nearly all written by members of the staff of the National Physical Laboratory, hence we have in them extremely valuable information of the actual methods used in this country. It is true that when reading the articles one misses information on some point or other which would have been useful, but everything cannot be included in a book of finite dimensions, and on the whole the choice of subjects is good. The only criticism one has to make in this respect, and it applies to the book in general, is that the articles are very uneven in the amount of detail given. There can be no doubt that "gauges" are an important accessory in all accurate measurements of length, but are they so important as to justify the longest article in the volume and more than fifty per cent. more space than is given to the article on metrology itself? One cannot help feeling that in this article we are taken outside applied physics into engineering practice.

The chief article on the measurement of time is one by Prof. Sampson on clocks and time-keeping. It is a delightful article to read, for while it is short and not overburdened with detail, there is no difficulty in grasping the principles employed in the different forms of clocks described. After reading these thirty pages, one has the feeling (it may not be justified) that one knows all there is to know about clocks and their ways from the Glastonbury Abbey clock of 1325 to the latest Riefler.

In the geophysical section we cannot help regretting that more space has not been allotted to the writers, even, if necessary, at the expense of the articles dealing with measurements, which in some cases, as already mentioned, are overburdened with detail. Some of the articles are so abbreviated as to lose a great deal of their usefulness; this is particularly the case with the article on meteorological optics, which consists of only sixteen pages, while the descriptions of thirty-two different map projections are compressed into five pages.

The articles by Sir Napier Shaw and Capt. Brunt indicate very clearly the great changes which have taken place during the present generation in the outlook of meteorologists. Meteorology has changed from being an observational study of weather and its changes to a study, largely deductive and mainly mathematical, of the atmosphere as a whole. It is not surprising, therefore, that one hears occasional complaints that the modern meteorologist is too fond of theory and long names. On the other hand, the recording of weather had gone on for many, many years without much progress in our knowledge of the "way of the air"; but in recent years the physicist and mathematician have looked our way and the progress has been startling. In this advance two names stand out pre-eminent in this country, Dines and Shaw, and both have written articles for this volume. Sir Napier Shaw's article on "The Thermodynamics of the Atmosphere" is characteristic, and therefore full of new ideas and new views of old ideas. He treats the atmosphere as a whole as a "heat engine" of the classical type. An indicator diagram of a novel type, in that the co-ordinates are temperature and entropy, is constructed, and we are taken through a "cycle of operations" which involves a return ticket from Java to "the cold slopes of the mountainous Arctic and Antarctic lands," and during the course of which we realise our entropy like a normal traveller cashes his circular notes, and occasionally we receive fresh funds from the water vapour which we have smuggled in our luggage. Sir Napier also introduces us to the "resilience of the atmosphere," from which "arises the capacity of a layer of air to act as a 'deck' or ceiling, preventing any vertical motion, and therefore limiting the motion of the atmosphere to horizontal layers." The whole article is stimulating and its value cannot be overrated.

Those of us who are interested in atmospheric electricity are feeling more and more the need for a good account in English of this branch of meteorological physics. There is more than enough material for a good-sized book, but the few workers in atmospheric electricity in this country have other interests, and there appears to be no immediate prospect of the need being satisfied. We have all the more reason, therefore, to be grateful to Mr. C. T. R. Wilson—one of the qualified workers who has other interests—for his article. There are so many unsolved problems in atmospheric electricity that any account of the work done and of the theories propounded to explain the observations must of necessity exhibit the personal opinion of the writer. This article is no exception, and Mr. Wilson's point of view is clearly discernible. His account is, however, perfectly fair, and as unbiassed as it could be in the circumstances.

Most writers have recently acknowledged themselves defeated in their attempts to explain the maintenance of the earth's normal electrical field, but Mr. Wilson makes it quite clear that in his opinion thunderstorms offer a way of escape from this impasse. The small amount of evidence which he adduces is not very impressive, but until more work has been carried out along the lines indicated by Mr. Wilson it will not be possible to say that his solution is incorrect.

We began this review with expressing gratitude to Sir Richard Glazebrook, and we cannot do better than end on the same note. The criticisms we have made are of secondary importance and are very much in the nature of looking a gift horse in the mouth. But there is no objection in examining the mouth if it helps one to understand the gift and to make the best use of it.

G. C. Simpson.

Climatic Changes.

(1) *The Evolution of Climate.* By C. E. P. Brooks. Pp. 173. (London: Benn Bros., Ltd., 1922.) 8*s.* 6*d.* net.

(2) *Climatic Changes: their Nature and Causes.* By Ellsworth Huntington and S. S. Visher. Pp. xvi+329. (New Haven: Yale University Press; London: Oxford University Press, 1922.) 17*s.* 6*d.* net.

"A HUNDRED million or a thousand million years ago the temperature of the earth's surface was very much the same as now," say Profs. Huntington and Visher in the first chapter of their "Climatic Changes" (p. 15). This uniformity of climate throughout geological time, in contrast with the inconstancy of the weather from day to day and from year to year, is the great paradox of geological meteorology. The climatic conservatism of the earth as a whole is qualified by great local changes which have produced glaciations at about ten different geological dates and acclimatised in high latitudes plants allied to those now confined to warmer regions. The study of climatic changes has the especial attraction that it is a tempting explanation of the fall of civilisations and States, since man is obviously dependent on the weather.

(1) The perennial controversy as to whether climatic change is due to terrestrial or to celestial causes is continued in the two new works by Brooks and by Huntington and Visher. While Mr. Brooks maintains that the climatic changes proved by geology can be explained by alteration in the distribution of land and water, the American authors attribute them to occasional changes in the condition of the sun. Mr. Brooks in expounding, his conclusion, rejects the atmospheric theories based on variations in the amounts of carbon dioxide and of volcanic dust, and his verdict on this question is given added weight by Dr. G. C. Simpson's testimony, in an introductory note, to his authority on meteorology. Mr. Brooks explains the last main geological change of climate as due to great uplifts of land in high latitudes having enlarged both polar glaciers and tropical deserts. He "shows how enormously effective the land and sea distribution really is," by calculating what the temperatures on one zone on the earth would be if it were composed solely of land or were occupied entirely by sea. In a useful appendix he provides data by which the effects on temperature of variations in land and sea can be calculated.

Unfortunately, the meteorological sections of Mr. Brooks's work are relatively short, and most of it is devoted to accounts of geological and historical variations of climate on which the author's opinions are less authoritative. He adopts the views of Prof. Ellsworth Huntington that some great political changes in classical times were due to a climatic change in the southern part of the North Temperate zone. These views were discussed and rejected in a paper in the *Geographical Journal* (vol. 43, 1914, pp. 148–172, 293–318), and as Huntington and Visher, who quote that paper, say (p. 92) that in the main its "conclusions seem to be well grounded," the former author has apparently abandoned some of the views which Mr. Brooks still quotes on his authority. That section of Mr. Brooks's work is out of date, as is also the argument based upon the occurrence of Galaxias in South America and New Zealand, since the discovery that this fish breeds in the sea. The main value of Mr. Brooks's book depends on its meteorological chapters and its weighty support to the conclusion that glaciations can be explained by geographical changes. He omits reference to the impressive testimony on behalf of that theory by Lord Kelvin.

(2) The interesting and suggestive volume by Messrs. Ellsworth Huntington and Visher shows an exceptional knowledge of the literature and contains an illuminating discussion of important problems on the borderland of meteorology, astronomy, and geology. They discuss Brooks's paper in support of the geographical explanation of glaciations, but dismiss it, since the distribution of ocean and continent at the time of the Pleistocene glaciation was much the same as it is now; the differences they claim were insufficient to have produced so great a climatic change. They admit that changes in the positions of land and sea may be an important secondary agency. Differences of opinion as to past climates are not surprising in face of the authors' divergencies of statement as to existing geography: "To-day the loftiest range in the world, the Himalayas, is almost unglaciated" (Huntington and Visher, p. 144); "The Himalayas, owing to their heavy snowfall derived from the south-west monsoon, bear numerous great glaciers . . ." (Brooks, p. 77).

The authors adopt the view that climatic changes are due to variations in solar activity. They have been convinced, in spite of a prepossession to the contrary, that the periodicity and seasonal variation in earthquake action and concurrent climatic changes are due to a planetary influence which also controls the appearance of sun-spots. They discuss the nature of this influence and conclude that it is not tidal but electrical. The effect on the earth of increased sun-spots is not by direct variation in temperature, since increased glaciation does not involve any general change in the earth's temperature, which the authors insist has been practically uniform throughout geological time. Increased solar activity affects the earth by producing special storminess, with increased snow-fall in areas of high pressure and diminished rainfall and loess formation elsewhere. If the planets have such an important though indirect effect upon the earth's climate, the approach to the solar system of some of the greater stars must from time to time have a still more powerful influence on solar activity. The authors claim that great stars may approach the solar system sufficiently to stimulate intense activity in the sun, and thus produce glaciations on the earth at intervals of time consistent with the requirements of the geological history of climate.

The views on geological climates put forward by Messrs. Huntington and Visher appear to be generally well substantiated, as in their belief in the existence of climatic zones throughout geological time (p. 171) and that (p. 169) "as far back as we can go in the study of plants, there are evidences of seasons and of relatively cool climates in high latitudes"; but their conclusions as to historic variations in climate are less well supported. They attribute the English famines of 1315–16 and 1321 to a special climatic stress due to a "considerable swing towards the conditions" that produce glaciations. In support of this view they quote Petterson (Quart. Jour. Meteor. Soc., vol. 38, 1912), that the 14th century was a period of extreme climatic variation, but they have overlooked Hildebrandsson's reply to Petterson's paper (Nov. Act. R. Soc. Sci., Uppsala (4), IV., 1915).

Famines are so often due to an untoward concatenation of many unfavourable circumstances that they are not a sure foundation for hypotheses of climatic change. Standard authorities on the historical distribution of famine do not support the view that the English famines in the early part of the 14th century were abnormal in origin. It is even doubtful whether that period was especially famine-stricken. Dr. Farr, in his classical paper on the variation of wheat prices (Journ. Statist. Soc., London, IX., 1846, pp. 158-174), shows that famines were evenly distributed throughout the 11th to 16th centuries. "In the 11th and 12th centuries a famine is recorded every 14 years on an average, and the people suffered 20 years of famine in 200 years. In the 13th century my list exhibits the same proportion of famine, and nearly the same number of years of famine. . . . Upon the whole, the scarcities decrease during the three following centuries; but the average from 1201 to 1600 is the same—namely, 7 famines, and 10 years of famine to a century. This is the law regulating scarcities in England." Walford's table of famines (Insurance Cyclopædia, 1874, vol. 3, pp. 165–170) shows that the rise in the price of wheat during the famine of 1315–16 was exceeded in that of 1437–38, when the rise of price from 4*s*. or 4*s*. 6d. a quarter to 26*s*. 8*d*. was higher than the quintuple increase upon which Huntington and Visher lay stress for 1315.

The English scarcity from 1581–1603 was equally far-reaching, as famine at the same time caused cannibalism in Ireland and devastated Persia. The famine in England from 1694–99, attributed also to "rains, frosts, snows—all bad weather," might have produced as disastrous consequences as that in the 14th century, but for the improvement in internal transport. An instructive table in Brooks's volume (p. 155) discredits the hypothesis that the English famine of 1315–16 was due to a period of abnormally severe weather, as it represents severe winters as fairly evenly distributed throughout the half centuries from 1075 to 1425. The discussion of the causes of these famines by Thorold Rogers ("Agric. and Prices in England," vol. i., 1259–1400, 1866, pp. 28–30), whom Huntington and Visher quote for facts about the 1315–16 famine, gives no support to the view that they were due to any progressive change in climate or to climatic severity of a special order.

J. W. Gregory.

The Copper Age in Spain and Portugal.

La Civilisation énéolithique dans la Péninsule Ibérique. (Arbeten utgifna med understöd af Vilhelm Ekmans Universitetsfond, Uppsala, 25). By Nils Åberg. Pp. xiv + 204 + 25 plates. (Uppsala: A.-B. Akad. Bokhandeln; Leipzig: Otto Harrassowitz; Paris: Libr. Honoré Champion, 1921.) 15 Kr.

IT is a pleasure to peruse the work of an author like Dr. Nils Åberg, whose studies are so comprehensive. Too many prehistorians work and publish in their own small area without much reference to cultures outside, or occupy themselves with the necessary, though in the long run barren, task of extracting the more important essentials from the ever-growing mass of literature in order to present a concise scheme that can be used by others as a basis of study. Dr. Åberg's objective is far wider in scope, for although his main interest is naturally in Scandinavia, the whole of Europe is really included for the purposes of his work. The volume in front of us is only the latest of a number of memoirs, the object of which is to trace, from a study of the typology of various objects, the directions from which came the influences that were at work in Europe from Neolithic to Bronze Age times.

Any prehistorian who has worked on the Continent will derive pleasure from the very first page, for the book is dedicated to Émile Cartailhac. To those who have worked with and drawn inspiration from Cartailhac such a dedication seems natural. But here it is not only a tribute to that wonderful old man, who died in harness only a short while ago, for his book, "Les Ages préhistoriques de l'Espagne et du Portugal," published so far back as 1886, still remains a standard work on early times in the Iberian Peninsula, and again and again the reader will notice the use that Dr. Åberg has made of it.

A great deal of work has been done by Dr. Åberg, and a number of collections, both private and in museums (not to speak of the considerable literature on the subject), has been utilised in the compilation of this work. The book opens with a short preface in which the author exposes his reasons for studying the area and his general views. There follows an introduction in which the current views and the literature of the subject are shortly discussed. Next, after giving an account of the background to the period under discussion, the development of the megalithic tombs in the Peninsula, and the principal objects and types of tool found during the Iberian copper age, are described and illustrated by numerous and excellent figures and plates. The whole forms an exceedingly useful study which can only be gathered elsewhere by a process of foraging in much larger works. There follows an account of a number of sites in Portugal and Spain; finally a brief comparative study of similar cultures elsewhere, in France, Italy, and England. Much local work has still to be published by Bonsor and others, and many details still await solution, but in the meantime, the volume before us gives a clear and rapid account of what has been done, and its important bearing on the contemporary cultures farther north. The Spanish Peninsula has been favoured in having large deposits of metal ores, and so a brilliant copper age developed, the influence of which was felt farther north in regions where stone tools still had to be used owing to lack of metal ores, at a time when little commerce was possible.

The book is lacking in one particular respect, and that is in the absence of an account of the Spanish "Third Group" rock-shelter paintings. This art clearly belongs in date to our author's period, for many of the conventionalisations figured on pottery appear on the walls of the rock-shelters. Thus on pages 133 and 145, decorations engraved on pottery from Los Millares and Las Carolinas are illustrated, which can be matched exactly by paintings on the rock-shelter walls (for example, at Jimena, at Las Figuras, and a score of other sites). This art was not purely decorative; it had some (as yet imperfectly known) object, and so is important in tracing out the civilisation of the period. It is true that there has not been as yet any complete or satisfactory study published on this subject, so that its importance has not been always properly realised.

Sufficient has been done, however, in this respect to make its omission from Dr. Åberg's book a serious blemish. This can easily be rectified in a later edition by the addition of a further chapter.

Dr. Åberg is to be congratulated on his excellent work, which indeed well repays a careful perusal.

M. C. Burkitt.

A Railway Manual.

Manuel des chemins de fer. Par J. Bourde. (Bibliothèque Professionnelle.) Pp. 444. (Paris: J.-B. Baillière et fils, 1922.) 12 francs.

M. BOURDE'S book is intended for workers who are desirous of extending their knowledge over larger fields than is covered by their actual every-day work, and for whom the big special volumes are inaccessible or unintelligible. The author is of opinion that the workman is too often condemned to be a mere wheel in a mechanism, and that he is not allowed sufficient initiative. The series of volumes to which our author's book belongs is intended to furnish opportunities for the workman, and each of the 150 volumes has been written by an author who has special knowledge of the subject on which he writes. The reason for the lack of works of this type in this country is probably connected with the difference between the French and English people in their mental characteristics and in their education. The English are of course intensely practical, and not at all bookish. It is not implied that the French are not practical, but they have been brought up more on the bookish side than English engineers. The present writer knows one railway engineer who is—or was—anxious to write a book on railways, and he had accumulated a great mass of material. His lack of literary skill and the immense volume of his own knowledge will, however, in all probability prevent the completion of the book.

The volume under review, dealing with railways from the engineering point of view, covers the ground very thoroughly; it is written in plain language and gives the essentials to such an extent that a person having already a practical acquaintance with any one branch of railway work would, by the aid of the book, readily fit himself to deal with problems outside his own special domain.

With regard to the details of the book, a beginning is made with surveying and levelling, the drawing of plans and representation of heights by contour lines and other methods. With this preliminary the author is in a position to tackle the general design of the railway line, including questions of traffic, gauge of rails, curves, and gradients, all from the most general point of view, and so as to decide on the best route. Other chapters discuss, from the same point of view, transition curves, cuttings and embankments, the calculation of earthwork, the latter subject being treated in considerable detail; also the problem of the economical arrangement of excavation and embankment, considered especially with respect to length of haul.

Assuming now that the actual route is decided upon, the author treats of the detail design and carrying out of the work, this portion of the book taking up more than one half of the whole 444 pages. There are six chapters treating in succession of the design and execution of cuttings and embankments, bridges, viaducts, culverts, and tunnels; then follow two chapters on masonry works with a general discussion of the materials to be used: stone, metal, wood, etc.

With all the earthwork finished, bridges and heavy masonry work completed, the next subject is the permanent way of the line, and the author gives a very clear and concise account of the several component parts, especially dealing with the rail, its different sections and methods of support, with a clear treatment of the gradual introduction of curvature on rails by means of transition curves. The planning of stations, with the various problems involved in the junctions and crossings of the tracks, is given fairly thoroughly, and a chapter is devoted to station buildings, including the buildings required for the rolling stock.

The book is of a type which would be welcome in Great Britain, although of course a translation would be of little use.

Our Bookshelf.

Carl Rümkers Hamburger Sternverzeichnis 1845·0, enthaltend 17724 Sternörter, abgeleitet aus den Beobachtungen am Meridiankreis der Hamburger Sternwarte in den Jahren 1836 bis 1856. Herausgegeben von Dr. Richard Schorr. Pp. xiv+488. (Bergedorf: Verlag der Sternwarte, 1922.) n.p.

Dr. Richard Schorr has rendered a great service to exact astronomy in making and publishing this re-reduction of the great Hamburg catalogue of Carl Rümker, containing 17,724 stars, mostly faint, observed with the Repsold Transit Circle (of 4 inches aperture) between 1836 and 1856. It is of interest to learn from the short biographical sketch of Rümker that he held a commission in the British Mediterranean fleet from 1812 to 1817, holding the post of instructor in navigation. He then went to Paramatta Observatory, N.S.W., as director; while there he made useful observations of Encke's Comet at its first predicted return in 1822. He returned to Hamburg as director of the Observatory in 1833, remaining there till his health failed in 1857. The Transit Circle was quite a good one, and the early date of the stellar observations renders them of value for the determination of proper motion.

The reduction has been repeated *ab initio*, the data being entered from the original observing books. The clock and azimuth errors and equator-points were derived by the use of Auwers's positions of fundamental stars. Pulkovo refractions were used. The probable error of a re-reduced catalogue place (depending on 1·8 observations, the average number) is 0·083^s secant decl. in R.A., and 1·0″ in decl. The difference of magnitude equation for 3·5 mag. and 8 mag. is about 0·08^s. This has not been applied. The star places were compared individually with those of the Astronomische Gesellschaft Catalogues and the differences are given beside the star places, though the interval in years is not given.

Many errata in Rümker's reductions were detected and corrected in the course of this comparison. These are mentioned in footnotes. There were some stars for which Rümker did not read the full number of microscopes, but in all cases there is ample material to determine the necessary correction. Finally a list is given of the proper motions that have been published for Rümker stars, some 6000 in number. It should now be possible to increase this list with the aid of the newly published positions.

To save expense the catalogue was not set up in type, but written by hand and multiplied by a mechanical process. It is, however, quite clear and legible.

A. C. D. C.

Mathematik und Physik: Eine erkenntnistheoretische Untersuchung. Von E. Study. (Sammlung Vieweg, Heft 65.) Pp. 31. (Braunschweig: F. Vieweg und Sohn. 1923.) 675 marks.

In this tract Prof. Study's chief aim is to discuss the question: What is to be regarded as mathematical and what as specifically physical in theoretical physics? How comes it that parts of mathematics and of physics can be combined so as to form a higher unity? For the purposes of his discussion he defines mathematics as the limit towards which present-day mathematics seems to him to be tending, in which it will include calculation by means of natural numbers (positive integers) with all that is based thereon, and nothing besides. When, for example, projective geometry is "arithmetised" by identifying a point, or a straight line, with the set of homogeneous co-ordinates representing it, the word point, or straight line, as the case may be, becomes merely a symbol bearing no logical relation either to the material world or to our concept of space.

Thus all branches of geometry, Euclidean or other, are logically independent of experience. Similarly "arithmetical physics," arising from the arithmetisation of the mathematical portions of physics, is based logically on calculation by means of numbers alone, developed in one particular direction, chosen from many possible alternatives on the basis of a judgment of value, not of cause, in so far as it is desired to make only investigations closely related to experience. Thus the relation of theoretical physics to the content of experience appears to be not logical, but only psychological and historical. The content of theoretical physics is threefold: (1) a purely mathematical part, characterised by the method of deduction; (2) an experimental part, characterised by the method of (incomplete) induction; and (3) an intermediate part, characterised by an independent method, that of "idealisation." By idealisation Prof. Study means the process whereby we substitute the simple abstract reality of mathematics for the infinitely complex and barely comprehensible reality of physics.

This tract can be recommended as a very stimulating introduction to the philosophical aspects of mathematics and physics by a writer who is eminently fitted for the task by the wide range of his knowledge as well as the importance of his own contributions to science.

Musical Acoustics based on the Pure Third System. By Thorvald Kornerup. Translated by Phyllis A. Petersen. Pp. 56. (Copenhagen and Leipzig: Wilhelm Hansen, 1922.) 2*s.* 6*d.*

In this little book the author discusses very fully the relations of the pitches of the notes in the various scales in just intonation and in a variety of temperaments. Instead of Ellis's logarithmic cents, the millioctave is here used, which (as its name implies) is one-thousandth of an octave instead of Ellis's one-twelve-hundredth of the octave. It is pointed out early in the work that for a pure intonation of the minor triad, D F A, the D must be only a small tone above C and a large tone below the just E. The fact that the major chord, G B D, equally needs a D which is a small tone below the just E and a large tone above C, does not seem to receive equal emphasis.

The book contains very many diagrams and tables. One of the most striking diagrams is the author's tonal circle in which the circumference contains a single octave, equal *angles* corresponding to equal *differences* of frequencies. Thus, putting one C at the starting-point on the circumference, the other notes occur at the following angles, the D being what is called in England grave D and denoted by D′. The ordinary D would be at 45°.

Angles .	0°	40°	90°	120°	180°	240°	315°	360°
Notes .	C	D′	E	F	G	A	B	C′

Quite a number of scales and temperaments are treated at length, special attention being directed to the nineteen steps to the octave, which is considered to be the consequence of the third system and the practical ideal. Other temperaments considered are as follows, and illustrate the fulness of the treatment:

No. of Tones.		Steps in Tone.		No. of Semi-tones.		Steps in Semi-tone.		Steps in Octave.	Author.	Date.
5	×	2	+	2	×	1	=	12	Aristoxenos.	c. 350 B.C.
5	×	3	+	2	×	2	=	19	Elsasz.	c. A.D. 1590.
5	×	5	+	2	×	3	=	31	Vicentino.	c. 1546.
2; 3	×	6; 7	+	2	×	4	=	41	Paul v. Janko.	1882–1901.
2; 3	×	8; 9	+	2	×	5	=	53	Nicholas Mercator.	c. 1675.

The work is in some respects rather fanciful but will repay careful study.

E. H. B.

Production économique de la vapeur. Par Dr. O. Manville. Pp. vii + 407. (Paris: Gaston Doin, 1923.) 25 francs.

M. Manville's work is timely. While French industries in pre-War days consumed 64 million tons of coal, the addition of Alsace-Lorraine has increased the potential demand to 80 million tons. To meet this there exists but 25 to 30 million tons from the French mines (compared with 40 millions in the days when the mines had not suffered from war), leaving a possible gap of 55 millions in the balancing of the account. The author, who is obviously alarmed by these figures, estimates the supplies from Belgium, England, the Saar, and Lorraine as but 29 millions and speculates doubtfully on the prospect of getting regularly the required balance from Germany. He points out that in any case the cost of the imports must be in the neighbourhood of 6 milliards of francs, unless the present wasteful methods of coal utilisation are changed. To the elimination of these wasteful methods the author accordingly addresses himself, suggesting that in the matter of steam production alone two of the six milliards can be saved.

The book contains a full and satisfactory account of modern steam plant and its various accessories, besides giving much space to calculations. The author remarks, "La plus grande partie de nos usines ont une origine modeste. Ce sont de petites installations, qui se sont développées, au cours d'affaires plus ou moins heureuses." Those in charge of the modest organisations of which he speaks may find the book rather difficult, but their remedy is simple since the author is a consulting engineer and his personal assistance will doubtless be available on demand.

The Sea Gypsies of Malaya: An Account of the Nomadic Mawken People of the Mergui Archipelago. By W. G. White. Pp. 318. (London: Seeley, Service and Co., Ltd., 1922.) 21*s.* net.

The Mawken of the Mergui Archipelago, more generally known as the Selung, whose customs, beliefs, and modes of life are described in this volume, are literally nomads of the sea, as the greater part of their life is passed in their peculiarly constructed boats. The reason they themselves give for this mode of existence is, that after they had migrated from the mainland, whence they had been driven by the incursions of Burmese peoples, they had to abandon their settlements on the islands owing to the raids of Malayan pirates. It is a moot question whether they are to be regarded on linguistic grounds as the northernmost branch of the sea-going Malays or as a derivation from Further India. Their own traditions, as already mentioned, favour the latter origin. As the author was in charge of the census of these people in 1911, he was able to obtain a considerable insight into their system of relationship, of which a remarkable feature is the stress laid upon the distinction between elder and younger in most, but not all, the degrees of relationship. It is a pity that Mr. White's work has called him to another part of the world and that he will not be able to carry out further investigations among this interesting and little known people.

The Meaning of Meaning: a Study of the Influence of Language upon Thought and of the Science of Symbolism. By C. K. Ogden and I. A. Richards. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. xxxii + 544. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co. Inc., 1923.) 12*s.* 6*d.* net.

This rather pretentious volume is at least twice the size it need have been in consequence of the choice by the editors of uncomfortably large type and extravagant spacing. Its title is apparently adopted from the subject of a symposium at the Oxford philosophical congress of 1921, and the book is a medley of already published papers and editorial paragraphs. The collaborating authors of the main essay apologise in the preface for its lack of systematisation, and make the excuse that their lives are too busy for them to spare the time necessary to re-write it. They have included in their book an introduction by a third author and supplementary essays by a fourth and fifth. The aim of the whole is to provide materials for a science of meaning. The book contains a good deal of amusing matter and some valuable criticisms, but it is formless and unequal.

Chile: To-day and To-morrow. By L. E. Elliott. Pp. x + 340 + plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1922.) 24*s.* net.

Among recent books on Chile this stands out as one of the most important and fullest for purposes of reference, although its value in this respect is somewhat impaired by the lack of an index. The sections on Chilean history and on mining and agriculture are particularly full and useful. The book would be enhanced by more attention to the physical features and climate of the country, which are both treated very briefly. Like most books on South America this volume is mainly eulogistic, but the critical note is not absent, and the author clearly has a wide experience of the country. There is an interesting chapter on Easter Island, the distant possession of Chile in the Pacific.

Elementary Determinants for Electrical Engineers. By H. P. Few. Pp. vi + 98. (London: S. Rentell and Co., Ltd.; New York: D. Van Nostrand Co., 1922.) 4*s.* net.

In many of the everyday calculations of electrical engineering, determinants are useful, and Prof. Fleming showed many years ago how the resistances of networks can be computed by their means. The very complicated formulæ which telephone engineers use in order to balance the capacity effects in multiple twin cable are easily proved by determinants. This book can be very easily understood, and will be appreciated by those for whom it is written. The examples are numerous and well chosen.

Optical Methods in Control and Research Laboratories. By Dr. J. N. Goldsmith, Dr. S. Judd Lewis, and F. Twyman. Vol. 1: Spectrum Analysis, Absorption Spectra, Refractometry, Polarimetry. Second edition. Pp. iv + 56 + 3 plates. (London: Adam Hilger, Ltd., 75A Camden Road, 1923.) 1*s.* 6*d.*

This pamphlet forms a valuable introduction to the use of spectroscopes, spectrophotometers, refractometers, and polarimeters, and, while avoiding detailed descriptions of the instruments, gives ample references to such descriptions. Sufficient information is given in the pamphlet to enable a works physicist to select the proper instrument for the work to be done and to know where to look for further information on the subject.

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.*]

The Crossed-orbit Model of Helium, its Ionisation Potential, and Lyman Series.

TAKING for granted the dynamical legitimacy of the crossed-orbit model as originally proposed by Bohr (*Zeits. für Physik*, ix., 1922, p. 1) for normal helium, I find for its negatived total energy, with the usual Coulomb law of force, and treating the two orbits as "*circular*" *in the literal sense of the word*,

$$-E = 7N_\infty ch\left[1 - \frac{1}{4\pi}F\left(\sin\frac{i}{2}\right)\right], \quad . \quad . \quad (1)$$

where F is the complete elliptic integral of the first kind, i the inclination of the planes of the two one-quantic orbits, in Bohr's case 120°, and the remaining letters are the usual symbols of the universal constants. In accordance with symmetry, the electrons are assumed simultaneously to pass the nodes, that is, the opposite ends of the common diameter. (Details of deduction of (1) are given in a paper to be published shortly.) If one of the electrons be removed to "infinity," the energy of the remaining ionised atom He^+ is $-4Nch$, where $N = N_\infty : (1 + m/M)$. The small difference $N_\infty - N$ being irrelevant for our purpose, the ionisation work thus becomes, by (1), $W = Nch(3 - 7F/4\pi)$, or, the equivalent wave-number (of the flash emitted at the return of the removed electron),

$$\nu = N\left[3 - \frac{7}{4\pi}F\left(\sin\frac{i}{2}\right)\right]. \quad . \quad . \quad . \quad (2)$$

For Bohr's model $i = 120°$ and, to four decimals, $F = 2{\cdot}1565$. Thus $\nu = 1{\cdot}7987N$, and since N is equivalent to 13·54 volts, the corresponding *ionisation potential*,

$$V = 24{\cdot}35 \text{ volts}, \quad . \quad . \quad . \quad . \quad (3)$$

which is remarkably close to 24·5, the latest value observed and corrected by Lyman. The wave-length corresponding to (3), or the limit of Lyman's new series, would amount to $\lambda_\infty = 506{\cdot}8$ Å.

Thus far Bohr's (idealised) model, corresponding to $-\cos i = \frac{1}{2}$, a value supported in Bohr's paper (*l.c.*, p. 32) only by a terse reference to the quantum condition for atomic angular momentum.

Now, suppose for the moment that there are dynamically possible states of the system also for some inclinations differing from 120°. Then the wave-number emitted at the passage from He^+ to such an i-model will be given by (2), with $N = 1{\cdot}097_3 . 10^5$ as a sufficiently correct compromise value. It has seemed especially interesting to apply (2) to *simple rational values* of $-\cos i$ other than $\frac{1}{2}$, with a particular view of covering, perhaps, some of the observed members of Lyman's series, which are four,

$$\lambda_1 = 584{\cdot}4, \ \lambda_2 = 537{\cdot}1, \ \lambda_3 = 522{\cdot}3, \ \lambda_4 = 515{\cdot}7,$$

with the conjectured λ_∞ corresponding to 24·5 volts or, very nearly, to (3) as limit. The results thus obtained were as follows:

The "normal" value $-\frac{1}{2}$ being already treated, the next simple rational value $\cos i = -\frac{2}{3}$, to which corresponds $F = 2{\cdot}3404$, gave, by (2),

$$\lambda = 537{\cdot}2,$$

encouragingly close to the observed λ_2. The very next, however, $\cos i = -\frac{3}{4}$, yielding $\lambda = 561{\cdot}9$, was, for the present, without interest. Further, $\cos i = -\frac{4}{5}$, with the semi-inclination 71·585° and $F = 2{\cdot}5892$, gave

$$\lambda = 585{\cdot}0,$$

close enough to the observed λ_1, and $\cos i = -\frac{3}{5}$, $i/2 = 63{\cdot}435°$, $F = 2{\cdot}2571$, yielded

$$\lambda = 522{\cdot}9,$$

equally close to λ_3. But one observed member of the series, 515·7, remained uncovered. Working back from this, by (2), the required semi-inclination is found to be 61·97°, whence $-\cos i = 0{\cdot}558$, while the nearest simple fraction $\frac{5}{9}$ is 0·555. . . . But whether 5 and 9 are still "small" integers must be left to every one's own judgment. In fine, the formula (2), *regardless of its significance or deduction*, gives the correct ionisation potential for $-\cos i = \frac{1}{2}$, and at the same time, for

$$-\cos i = \frac{5}{9}, \ \frac{3}{5}, \ \frac{2}{3}, \ \frac{4}{5},$$

the observed Lyman lines λ_4, λ_3, λ_2, λ_1, respectively, the initial state being always that of He^+, and the final energy level being each time given by (1) with the corresponding inclination. Notice that for $i = 0$, $F = \pi/2$, and (1) gives $49{\cdot}8\,Nch$, the familiar energy level of Bohr's older (untenable) ring model.

Whether the model of normal helium ($i = 120°$), with almost circular orbits, is dynamically legitimate, seems doubtful. Finally, a decision with regard to the dynamical possibility of the remaining four configurations, leading to remarkable coincidences, would require a thorough and complicated analysis, which the writer is not in the position to offer. Unless some new lines are discovered beyond 500 Å., the domain worthy of investigation in this respect, on either the accepted or modified dynamical and quantic principles, would extend only from $i = 120°$ to less than 177·63°, the latter being the inclination for which the right-hand member of (2) vanishes, when the system is ready to break up of its own accord.

L. SILBERSTEIN.

Rochester, N.Y., March 1.

The Nature of Light-Quanta.

IN a letter to NATURE of April 21, 1921 (vol. 107, p. 233), Sir Arthur Schuster pointed out that a quantum radiation could not, on account of the finiteness of its energy, $\epsilon = h\nu$, be regarded as homogeneous light of frequency ν, for homogeneity implies, strictly, the existence of an infinite train of waves of constant amplitude.

Since all attempts to find a type of nearly homogeneous light with total energy $h\nu$ have been comparatively unsuccessful, it seems worth while to consider the hypothesis that an approximately homogeneous type of light is the result of the *interference* of two or more quantum radiations of an elementary character.

Let us assume that an elementary quantum radiation, in the form of a plane wave travelling in the direction of the axis of x, is specified by an electromagnetic field in which the electric vector E is transverse to the direction of propagation and represented by a vector of type $f(x - ct)$F, where F depends only on z and y and represents in magnitude and direction the electric force in a two-dimensional electrostatic field, of finite energy W, arising from positive and negative charges situated within a small finite area A in the yz-plane.

If $f(x) = \frac{\sin px}{x}$, the total energy in this electromagnetic field is πpW and is thus finite in spite of the fact that there are electric charges travelling in the direction of the waves with the velocity of light. These charges lie within a cylinder meeting the plane of yz on the boundary of A. The magnetic vector is perpendicular to the electric vector and equal to it in magnitude both inside and outside the electric charges. The Maxwell-Lorentz equations are satisfied everywhere, and the fact that we are able to specify a type of radiation the total energy of which is proportional to the maximum frequency $pc=\nu$ indicates that quantum theory may be quite compatible with these equations. That all frequencies up to pc occur is seen at once from the equation $\frac{\sin px}{x}=\int_0^p \cos qx\,.\,dq$. We are justified in regarding this type of field as elementary because, as Levi-Civita pointed out many years ago (*Comptes rendus*, t. 145, 1907), the electromagnetic force on the moving electricity vanishes everywhere and so the electricity moves freely under no forces and no forces are needed to keep it intact. In this connection it may be mentioned that the force of type $2\psi\nabla(\rho\sqrt{1-v^2/c^2})$, which has been used to balance the electric force in a suggested model of a stationary electron (*Physical Review*, September 1922), is also zero in the present case because $\psi=0$ and $v^2=c^2$.

Superposing two quantum fields with

$$f=\frac{\sin(p+dp)(x-ct)}{x-ct} \text{ and } f=-\frac{\sin p(x-ct)}{x-ct}, \text{ respectively,}$$

and with coincident cylinders (or light-darts, to use Silberstein's term), we obtain a wave of nearly homogeneous radiation of total energy $\pi W dp$. When the light-darts in the two fields are separate entities but close together, the total field still represents an approximately homogeneous type of radiation, but it also possesses some of the properties of a quantum radiation because the light-darts can be regarded as independent and one of them can be captured by an atom and its energy $h\nu$ absorbed while the other one escapes.

The composite field will behave like radiation of frequencies lying between ν and $\nu+d\nu$ when reflected and refracted if the elementary quantum-radiation behaves like light of frequency $\nu=cp$.

To test this point we have considered the reflection of our elementary quantum radiation at the surface of the moving mirror $x=ut$. The reflected wave proves to be one of the same type as the first, the electric vector being $-f(x+ct)\mathrm{F}$, where $f(x)=\frac{\sin p'x}{x}$ and $p'=p\frac{c-u}{c+u}$.

Thus Doppler's principle holds just as if pc were the frequency of homogeneous light instead of the maximum frequency contained in the quantum radiation. The energy relation $\epsilon'=h\nu'$ still holds and it looks as if W could be regarded as a universal constant hc/π.

It should be remarked that the elementary radiant field considered here is simply a particular case of a more general type of simple radiant field in which the rays and light-darts issue from a moving point. An ordinary type of electromagnetic field can be built up by superposing two or more simple radiant fields of this type and proceeding to the limit. If, then, ordinary electromagnetic fields are to be regarded as composite, there is nothing strange in regarding an approximately homogeneous type of radiation as composite.

H. BATEMAN.

California Institute of Technology,
Pasadena, California,
March 5.

Spermatogenesis of the Lepidoptera.

I SHOULD be glad of the hospitality of the columns of NATURE to reply to two observers whose papers in the December number of the *Quarterly Journal of Microscopical Science* have only recently come under my attention. Dr. Robert H. Bowen, of Columbia University, has investigated the spermatogenesis of the Lepidoptera, a subject which formed the first part of my series of papers on the "Cytoplasmic Inclusions of the Germ Cells." His account differs from previous ones chiefly in two respects—he states that the mitochondrial part of the spermatid is not a skein or spireme but a plate-work, and what is a much more interesting objection, he denies the previous descriptions of the metamorphosis of this skein into a tail-sheath, and instead describes it as degenerating, and the tail region being formed of a new central substance.

In the same Journal, Mr. Graham Cannon has redescribed the louse mitosome, and supports Dr. Bowen's conclusion that this body is not a skein but a plate-work. Dr. Bowen agrees with me so far as the general appearance of the material is concerned, but in a long discussion brings up a number of reasons for supposing that the body in question is a plate-work something roughly like the head of a fancy chrysanthemum. Mr. Graham Cannon has also given a similar and short account of his reasons for supposing that this body is actually a plate-work formed by a system of vacuoles.

Some years ago when Prof. Doncaster was writing his latest book, he came to see the material illustrating my view that the acrosome is always formed in association with the Golgi apparatus. He was shown my preparations of Smerinthus testes, and objected then to my description of the mitosome or nebenkern as a spireme. Dr. Bowen and Mr. Cannon will be glad to know this. However, I never found any reason to alter my views, even with such distinguished opposition, because it seemed to me that whether the "spireme" was formed of a flat ribbon, or a round string, it was actually pulled out as the spermatid lengthened, much like a ball of string. The figure formed by the mitochondria of the spermatid is not a matter of importance so far as concerns the larger questions surrounding the study of the cytoplasmic inclusions.

When, however, we turn to the second objection brought forward by Dr. Bowen, we find a matter of considerable importance. Dr. Bowen's "central substance" was believed to be the partly unravelled or pulled-out mitochondrial skein; it is figured by me in Plate 25, fig. 47, of my paper. His account of this new substance being something apart from the nebenkern or mitosome, and of the latter not taking direct part in the formation of the tail, is worthy of reinvestigation.

Except for Dr. Bowen's new interpretation of the formation of the sperm tail, he adds nothing new to our knowledge of the spermatogenesis of the Lepidoptera. His account is valuable, however, because of the fact that it confirms my drawings of the appearances of the material already described by me. Some of his spermatid cells are effete and drawn from bundles which are in the process of formation of atypic sperms. The whole question will be dealt with by me in a full account elsewhere. I merely take this early opportunity of stating my position.

Mr. Graham Cannon's statements will also be examined at length elsewhere.

J. BRONTË GATENBY.

Zoology Department,
Dublin University,
April 9.

A Static or Dynamic Atom?

Some writers still contrast the static atom of Lewis and Langmuir with the dynamic atom of Bohr, as if the two alternatives were mutually exclusive. It does not seem to be realised generally that any inconsistency there may have been between them has vanished completely with the publication of Bohr's later views on atomic orbits; speculations about chemical constitution based on the static atom can be translated directly into the language and conceptions of the dynamic atom.

The fundamental idea of Lewis is that non-polar combination consists in the sharing of electrons between atoms in such a way as to complete stable electronic configurations. If the sharing of an electron means the sharing of an orbit, and if the stable electronic configurations are those in which the groups of highest quantum number are completed, as they are in the rare gases: then the Lewis-Langmuir theory, expressed in terms of Bohr's conceptions, states that such compounds are formed when some of the electronic orbits, instead of surrounding one nucleus only, surround both, and therefore help to complete the quantum groups of both atoms. With this principle as a guide, it is merely a matter of linguistic alteration to interpret on the basis of a dynamic atom the conclusions which have been reached on the basis of the static atom.

Of course the question remains whether the theory can be true and whether such shared orbits are possible. This is a matter for quantum theory to decide. My last letter to Nature on this subject (November 25, 1920, vol. 106, p. 408) succeeded in eliciting from Prof. Bohr the first statement of the later and most exciting developments of his theory; perhaps this one will be equally fortunate!

Until the question is settled, it would be waste of time to make the necessary translation, even in a few examples. But it may be well to point out that, if this interpretation of the "sharing of electrons" can be accepted, the task of explaining chemistry according to the Lewis theory will probably be facilitated. For it seems likely that some limitations at present imposed upon the forms of sharing and upon the stable configurations could be removed. So far as I can see, Lewis's principle that only pairs of electrons are shared, and Langmuir's principle (in the original statement) that the stable configuration is always an octet, are based not so much on definite facts as on the need of some guiding principle if speculation is to be limited. The limitations suggested by the identification of stable configurations with the completion, or partial completion, of quantum groups are not exactly those which are usually adopted at present; but once more, while the whole basis of the theory is so uncertain, the attempt to decide the constitution of particular compounds is premature.

Norman R. Campbell.

The Zwartebergen and the Wegener Hypothesis.

Critics of the Wegener hypothesis have made a good deal of capital out of the northward deflexion of the folds of the Zwartebergen on approaching the west coast of Africa, but their failure to point out the cause of this deflexion seems to me to lay them open to the charge of advocacy which they so freely lay at Wegener's feet.

The deflexion is produced by the incidence of the chain on a massif of older rocks of the Swaziland System with a core of granite trending north-west. On nearing this resistant axis, the folds bend north-west and then north forming the Cederbergen. Finally, they flatten and die out northwards. It is clear that the existence of the granitic axis has interfered with the direct westerly continuation of the folds. The interference, however, is only local, for the Cederbergen do not continue for any distance to the north.

An exactly analogous deflexion occurs in the case of the Armorican folds in Ireland where they impinge on the highly resistant north-easterly trending Wicklow chain with its massive granitic axis. The folds turn north-east in Tipperary as they approach the granite and then north in Kilkenny and Queen's County, where they flatten out and finally disappear. The analogy is very perfect in that the final deflexion from the general trend of the folds is greater than would be brought about by a mere falling into line with the Wicklow chain.

Now, as every one is aware, the interruption along the line of the Wicklow granite does not stop the Armorican folds. They are renewed on the other side of St. George's Channel in southern Wales, where they once more assume their normal direction. If, therefore, we imagine the supposed Atlantic rift valley to have opened up along St. George's Channel, so as to leave Ireland attached to Newfoundland, we may profitably consider what would have happened when one of those irrepressible Germans had come along and announced that it once formed part of the British Isles, basing his argument on the fact that the Irish and Welsh folds, as well as other geological structures, fitted one another when the countries were placed in juxtaposition. The critics would at once have objected that the Armorican folds in Ireland on the west side of the Atlantic turned up northwards before they reached the coast, and therefore could not be regarded as a continuation of those of Wales. It is clear that the objection would have no force in this instance, so one may well ask whether it has any in the actual case of Africa and South America.

W. B. Wright.

Manchester, March 31.

Egyptian Water-Clocks.

Permit a brief correction to the paragraph in Nature of April 7, p. 479, on the casts presented to the Science Museum. The variable divisions of the water-clocks are not for different lengths of day, but compensations for the changes of viscosity of water, over 9° and 12° F. respectively. This is proved by the extremes being nearer to the equinoxes than to the solstices, to harmonise with the slow passage of heat through massive temples. Further, the conical form of the clepsydra of 1400 B.C. was to compensate for the greater flow under fuller pressure, the form being a near approach to a portion of a parabola. Thus the variation of pressure was as 1 : 3·7, and the water varied as 1 : 2·9 to meet this.

W. M. Flinders Petrie.

A Permanent Image on Clear Glass.

After silvering an ordinary clock glass (about 5 in. diameter) on the convex side, I noticed on removing the wax, with which the concave side had been protected, that a perfectly distinct image of a small child's head had been rendered visible. The image is a photographic "positive."

It occurred to me that the clock glass had possibly been a photographic plate at some earlier time. Presumably it was a plane surface then. In giving the glass the curvature requisite to a clock glass it would be expected that any silver which may have been deposited while the plate was flat would have been disturbed when the glass had been moulded in a molten condition to its present shape. The image, however, is not distorted in the slightest degree.

I should be glad if any readers of Nature would supply an explanation of the production of this image.

Eric Robinson.

Bedford School, Bedford,
March 24.

I must thank the Editor for the opportunity he has given me of examining the very interesting silvered reflector specimen submitted by Mr. Robinson.

The image of the child's head has evidently a photographic origin, as Mr. Robinson suggests, but that the glass was at some earlier time a photographic plate that had later been heated and allowed to settle down in a suitable mould seems to be improbable, for the following reasons:

The image occupies only a small part, about an inch square, near the edge of the plate, the remainder of which shows no photographic details. There is, as Mr. Robinson remarks, no evidence of distortion at the curved portions, and a close examination of the surface shows none of those minute fractures that are usually visible when an old photographic plate is stripped and silvered.

When the image is examined closely, it is seen that there is a sharp line of demarcation especially at the right-hand side and the bottom, which suggests that at some time the head has been cut from a photograph and pasted inside the clock face. As the result of contact, or possibly under the action of the light, the image has then been impressed upon the glass. At some later date the photograph has been removed but the image on the glass has persisted and been rendered visible by silvering.

There are many examples of images being formed in the manner described on glass surfaces. A "To Let" notice pasted inside a window often becomes imprinted on the glass, and the image may persist thereafter for a very long time. Recently I observed on a tramcar window the wording of an advertisement that had been pasted on the glass and later removed. Silvering would of course make the images much more conspicuous.

In the hope of being able to reproduce Mr. Robinson's specimen, two photographs were attached with water inside a similar clock face and exposed to the light of an arc lamp for four hours. After the photographs had been removed the surface was thoroughly cleaned and silvered. Notwithstanding the briefness of the exposure, the images were then quite recognisable.

As there was reason to think that the appearance might be wholly or partly attributable to contact rather than exposure to light, a glass surface was cleaned with caustic potash and upon it there was roughly sketched a face by means of a quill moistened with stannous chloride. The liquid was allowed to remain for two minutes on the surface of the glass, which was then recleaned by means of a cotton-wool pad and weak caustic potash solution. After silvering, the details of the sketch could be observed, although previously no traces were apparent.

Another plate was similarly treated but not silvered. When this plate is breathed upon, the face can be distinctly seen.

The subject is one that deserves fuller investigation.

So materialistic an explanation as the above is not, I fear, so attractive as a psychic one.

James W. French.

Anniesland, Glasgow, April 9.

Tactile Vision of Insects and Arachnida.

It would be interesting to know more details of the research carried out by Mr. J. P. O'Hea on the "so-called eyes in insects and arachnida" (Nature, April 14, p. 498, in connexion with Commander Hilton Young's suggestion), from which he arrives at the surprising conclusion that "the organs generally known as eyes do not act as organs of vision." The species Mr. O'Hea mentions are the house-fly, red ants, *Tegenaria domestica*, and "many of the Epeiræ." We have here an assortment of which the power, and even manner, of vision are scarcely comparable.

Taking first the spiders, sight plays practically no part in the life of the common Epeirides; the eyes, so far as one can see, simply serve to distinguish light from darkness, and form no clear image. This is not quite true of Tegenaria (the other spider mentioned). A sudden movement of the hand, when the spider comes out to take a fly, I have known to send it back (this is also true of *Agelena labyrinthica* and others). In this case, however, it is a large moving object which frightens the spider, and it will hesitate in its attack if the insect cease to struggle, so that it does not find it by sight.

As for the red ants (the species is not stated), we have the mass of Lord Avebury's work, as well as that of Forel and many others, in determining the part vision plays. One of the simplest cases is that quoted by Forel ("Senses of Insects," pp. 124-128), in which he found that specimens of *Formica pratensis* experienced considerable difficulty in finding the nest when their eyes were varnished (the antennary sense, however, playing the most important part).

It is in the case of the house-fly that Mr. O'Hea's conclusions are most surprising. He maintains that if one gradually brings the hand up to a fly on a window-pane, "if it be a vigorous specimen, [it] will evade the caress," whereas if one approaches it from the other side of the pane the fly takes little notice. His conclusion is that the fly recognises the approach of the hand, not by vision but by currents of air due to the motion of the hand or by convection currents due to heat of the same.

I have lately had occasion to catch a number of flies (*Musca domestica* and *Calliphora vomitoria*), and have found that one of the best ways was to bring a glass tube slowly and continuously up to the fly (any sudden movement almost always causes the fly to escape). If the movement is quite steady, the fly does not realise the situation until covered by the tube; it cannot apparently appreciate a slow movement.

When the fly is on the other side of the glass we have several factors to consider. For example, if the fly is *outside*, its field of vision *below itself* will be limited owing to bright reflections all round (its eye being close to the glass); hence movements from inside, even if the fly could see below itself, would have to be sudden and on a larger scale to disturb it.

The most obvious test to apply is as follows: Approach the under side of the fly (1) through glass, when, as stated, it often takes no notice; (2) through trellis (such as a meat-safe is made of), when, in my experience, the same thing occurs. This seems to dispose of the idea that the fly is affected by convection currents. The explanation of the facts I should suggest to be somewhat as follows: The surface of the compound eye available to the fly for looking downwards is smaller than that on the top of the head. Moreover, the lower portion is never used when the fly is resting normally on a solid opaque body and the fly has only to take into account attacks from above. An attack from below (when the fly is at rest) is outside its normal experience. One may recall also that the ocelli are situated on the top of the head and are usually considered to be useful for close vision. The experiment, to be in any way conclusive, should be repeated with the eyes of the fly varnished.

Mr. O'Hea must, however, have more facts which enable him to deny the use of an insect's eyes for vision in the face of all the work of Lord Avebury, Plateau, Forel, and many others.

As for Arachnida, an immense number of examples could be quoted as indicating power of vision. The following are obvious (and are cases where "convection currents" are definitely excluded):

A male Attid will start to dance before the female, though a glass partition separate them, and he turns his head to watch her as she moves.

I have at present two specimens of *Lycosa Narbonensis*, which, when out of their burrows, will dart back when a sudden movement is made near them, that is within about three yards. (They are always under glass, so that convection currents will explain nothing.) A slow approach, as with the fly, does not disturb them.

It seems to me that, in testing, Commander Hilton Young's hypothesis, we cannot assume the absence of insect vision on such slender evidence as that brought forward by Mr. O'Hea. We must either experiment with species which are *known* to possess *absolutely no power of sight*, or obliterate the eyes with a varnish, and *then* see how the insect behaves in the neighbourhood of a solid body.

G. H. LOCKET.

Salmon's Cross, Reigate, Surrey,
April 15.

Science and Economics.

PROF. SODDY is an eminent chemist and physicist, and it is consistent with his own investigations that he should seek for the "natural fundamental basis of the economic system under which we perish" (NATURE, April 14, p. 497). If the natural basis of the system be such as to cause us to perish, the object of a re-examination is, perhaps, to alter Nature and reconstruct *de novo*. Or, does Prof. Soddy mean that there are natural economic laws of which we are, as yet, not aware, and for which we should search? We know, however, that nineteenth-century economists enunciated natural laws of economics such as *competition* (survival of the fit) and *supply and demand* (action and reaction). These laws, nevertheless, were not "natural" to economics; they were adapted from Nature, as then expounded, and applied artificially by the governments in certain countries.

Prof. Soddy now says, and with some reason, that the present economic system is an offence against common sense. It seems then that the natural obvious truths of the nineteenth century as interpreted economically are, in this century, both unscientific and senseless. Many no doubt will agree with him that the complex modern financial system which evolved through several centuries *pari passu* with science, and admirably served to stimulate, restrain, and direct the desires and ambitions of an imperfect human race, does not function as responsively as it did. Age may be the cause; it has not renewed itself by new forms of thought as has science. But, whatever the cause, one ventures to disagree with Prof. Soddy when he says that no one pretends to understand the system. This is true only as one might say "no one pretends to understand the 'atomic' theory": a few do—that is, those who conduct the operations. Certain axioms hold good until new conditions are introduced; but it is somewhat easier, one would think, to find the formulæ necessary to control operations under new conditions in a laboratory than in the world of human affairs. In the former, mathematics are at hand, but of what assistance are these scientific methods in dealing with complex and unequally developed human beings whose conflicting desires and opinions cannot be mathematically computed and resolved by formulæ?

Again, Prof. Soddy's assertion that the production of wealth is now "a relatively finished science" has a ring of finality hitherto unassociated with science. Many civilisations have shown evidences of great wealth, and its *production* is always a finished science at any time in an epoch, though relatively so to another. In our own day the need for human labour has not yet been entirely eliminated. It is even less probable that the *distribution* of wealth will ever become a finished science—at least, until "Earth's last picture is painted." Were the dispensers of credit (whether by patronage or "democratic control") to achieve a temporary perfection in adjusting the desires and deserts of the social hierarchy even in regard to material things, the mere force of individuality in human beings would upset the balance in time, and the fact of evolution makes this event inevitable, as history shows. There may be a science of the distribution of wealth, and, if so, it is probably associated with the science of government, an art in which rulers and princes of earlier times were especially trained; but one must conclude that its principles are not those of applied physics, for mankind cannot be controlled, transmuted, and led so rapidly and readily on the path of evolution as can the "elements" in the physicist's laboratory.

The ultimate basis of credit in any age is character and ability, on which have been founded the Codes of Laws and social formulæ of all great civilisations from the earliest Laws of Manu. It may be as well, therefore, for the preservation of our modern knowledge, that the system by which "tokens of wealth" are distributed should not be radically changed until character is once more clearly defined and appreciated by all classes.

W. WILSON LEISENRING.

Oakley House, Bloomsbury Street,
London, W.C.1, April 16.

Effect of Plant Extracts on Blood Sugar.

(BY CABLE.)

IN the early days of my investigations in connexion with insulin, I predicted that whenever glycogen occurred in Nature an insulin-like substance would also be found. Putting this theory to the test, I obtained positive results first with clam tissue, and later with yeast. This result was obtained during the latter part of January. In the light of this latter result, my mode of reasoning was changed. If yeast contains an insulin-like hormone, other plants may also contain it. Extracts of tissue of a variety of the higher plants were, therefore, prepared, and the effect of subcutaneous injection of these extracts upon the blood sugar of the normal rabbit was ascertained. The effect of certain plant extracts upon the blood sugar of depancreated dogs was also studied. Extracts made from onion tops, onion roots, barley roots and sprouted grain, green wheat leaves, bean tops, and lettuce were found to produce marked hyperglycæmia in normal rabbits. The day following the administration of an extract of green onion tops to a depancreated dog with a blood sugar of 0·190 per cent., a blood sugar of 0·090 per cent. was observed. The results of this investigation were communicated to the Society for Experimental Biology and Medicine at the meeting in New York City on March 21, when I suggested the name "Glucokinin" for this new plant hormone. Since that date I notice in NATURE of March 10 a letter by Messrs. Winter and Smith stating that they have obtained positive results with yeast extracts. These authors would, therefore, share coincident priority with me in this particular.

J. B. COLLIP.

Biochemical Laboratory, University of Alberta
April 21.

The Interferometer in Astronomy.[1]

By Prof. A. S. Eddington, F.R.S.

To the naked eye the stars and planets equally appear as points of light. A telescope magnifies the planets into discs, but no telescope is large enough to render visible the disc of a star. We can calculate that a lens or mirror of 20 ft. aperture would be needed to show us even the largest star disc; the construction of such an instrument, if not hopeless, is far distant. We have considerable knowledge as to the size of stars, but until recently it was all found by indirect calculation; no test had made out the image to be other than that of a geometrical point. At the risk of going over familiar ground I must consider briefly the mode by which a telescope forms an image—in particular how it reproduces that detail and contrast of light and darkness which betrays that we are looking at a disc or a double star and not a blur emanating from a single point. This optical performance is called resolving power. Resolving power is not primarily a matter of magnification but of aperture; provided we use an eyepiece of reasonably high power the limit of resolution is determined by the size of aperture of the object-glass.

To create a sharply defined image the telescope must not only bring light where there ought to be light, but it must also bring darkness where there ought to be darkness. The latter task is the more difficult. Light waves in the æther tend to spread in all directions, and the telescope cannot prevent individual wavelets from straying on to parts of the picture where they have no business. But it has this one remedy—for every trespassing wavelet it must send a second wavelet by a slightly longer or shorter route to interfere with the first, and so produce darkness. This is where the utility of a wide aperture arises—by affording a wider difference in route of the individual wavelets, so that those from one part of the object-glass may be retarded relatively to and interfere with those from another part. A small object-glass can furnish light; it takes a big object-glass to furnish darkness.

Recognising that the success of an object-glass in separating double stars and other feats of resolution depends on the production of darkness in the proper place by interference between the waves from different parts of the aperture, Michelson asked himself whether the ordinary circular aperture was necessarily the most efficient for giving the required interference. Any deviation from the circular shape is likely to spoil the definition of the image—to produce wings and fringes. The image will not so closely resemble the object viewed. But, on the other hand, we may be able to sharpen up the tell-tale features. It does not matter how different the image-pattern may be from the object, provided that we are able to read the significance of the pattern. If we cannot reproduce a disc, let us try to produce something which is *distinctive* of a disc.

A little reflection suggests that we ought to increase the resolving power by blocking out the middle of the object-glass and using only two extreme regions on one side and the other. For these regions the difference of light-path is greatest, and the corresponding wavelets are the first to interfere; they are the most efficient in furnishing the dark contrast needed to outline the image properly.

But if the middle of the object-glass is not going to be used, why trouble to construct it? We are led to the idea of using two widely separated apertures, each involving a comparatively small lens or mirror—after the pattern of a range-finder. That is much easier to construct than a huge lens circumscribing both apertures.

It is one thing to detect a small planetary or nebular disc; it is another thing to make a close measure of its diameter. It is one thing to detect the duplicity of a star; it is another thing to measure the separation of the components. Michelson's first experiments were directed not towards performing feats of resolution beyond what had previously been attained, but towards improving the accuracy of measurement. He applied his method first to measuring the diameters of Jupiter's satellites—discs which are easy to detect, but very difficult to measure trustworthily with an ordinary micrometer. But it is easier to understand the application of the method to measurement of double stars than

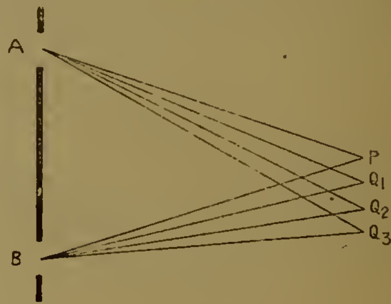

Fig. 1.

to the diameters of discs; and I shall therefore speak more particularly of the double-star problem first, although that is not the historical order.

Consider light coming from a distant point and passing through two small apertures, A and B, the rest of the object-glass being blocked out (Fig. 1). From each aperture the light disturbance diverges in all directions, and our problem is to find the nature of the luminous pattern formed in the focal plane, this pattern constituting the image which is viewed and magnified by the eyepiece. At the point P (where, according to geometrical optics, the single point-image ought to appear) we have full illumination because the waves from the two apertures have equal paths, AP and BP, and reinforce one another. A little to one side we have another point of full illumination, Q_1; the paths, AQ_1 and BQ_1, are unequal, but differ by exactly a wave-length, so that the waves again arrive in the right phase to reinforce one another. Similarly we shall have a series of points of full illumination, Q_2, Q_3, etc., where the path-difference amounts to 2, 3, etc., wave-lengths. Intermediately there will be points of darkness where the path-difference is $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$ wave-lengths, and the waves arrive in opposite phase and

[1] From the presidential address delivered before the Royal Astronomical Society on February 9, on presenting the gold medal of the Society to Prof. A. A. Michelson.

cancel one another. The light-pattern viewed by the eyepiece is thus a line of alternate bright and dark fringes. At first sight it might seem that the fringes would continue of equal brightness to a great distance; but actually they soon fade away, because in the more oblique directions there is interference, not merely between the two apertures, but between different parts of the same aperture. In fact the fringes appear as fine detail in the midst of the small diffraction disc which would be formed by either of the apertures singly.

Arrange that the two apertures are movable, and widen their distance apart. The points Q_1, Q_2, Q_3 now come closer together, that is to say, the fringes contract. Decrease the distance and the fringes spread out. It is a simple matter to find a formula giving the width of the fringes for any given separation of the apertures.

When the object viewed is a double star—two points of light—each point will produce its own line of fringes, and these will be superposed if the double star is a close one. It may happen that the two systems of fringes are in step, in which case the alternate bright and dark spaces will be conspicuous: but if they are at all out of step the pattern will be blurred. Remembering that we can alter at will the width of the fringes by varying the separation of the apertures, we can adjust them, so that the bright fringes for one component coincide with the dark spaces for the other component. If the two systems are of equal brightness one system will fill the gaps in the other, leaving merely a line of uniform brightness; if the two components are of unequal brightness the same adjustment will give minimum visibility of the alternation of light and shade. Varying the distance between the apertures this critical position can be fixed with considerable precision; and for close double stars of not too unequal magnitude the separation is measured in this way much more accurately than with a micrometer.

The disc of a single star or planet is likewise measured by finding a position of the apertures for which the fringes disappear. It is not now a problem of two points producing overlapping fringes, but every point of the circular disc produces a fringe-system, and the effects must be summed. When the diameter of the disc is 1·22 times the width of the fringes (*i.e.* the distance from one bright fringe to the next) the integrated effect is uniform illumination and the fringes disappear altogether. It is not much use trying to see in one's head a result which is more fittingly the subject of algebraic calculation; but we may notice in a general way that with this ratio the two outer quarters of the disc fall at places where the central half is producing dark spaces. That indicates roughly how the different portions of the disc compensate one another. The observation consists in varying the separation of the aperture until the fringes disappear; the diameter of the disc is then 1·2 times the fringe-width calculated for that separation.

The possibilities of a method of this kind had been explored to some extent before Michelson took up the problem; indeed Stéphan in 1874 had attempted unsuccessfully to detect the discs of stars by this means. We owe to Michelson the practical demonstration of its success. His first paper appeared more than thirty years ago in the *Philosophical Magazine* for July 1890. The next year he followed up the theory by measuring the diameters of the four satellites of Jupiter at the Lick Observatory. The method proved entirely successful, and his measures were afterwards closely confirmed by Hamy at the Paris Observatory in 1899 using the same device. The great value of the method seemed to be proved; it was thoroughly tested; and it forthwith lapsed into oblivion.

In 1919 Michelson again took up the matter with energy. He made observations in August with the 40-in. refractor at Yerkes which were found to be encouraging; and he went on to use first the 60-in. and then the 100-in. at Mount Wilson with the more ambitious design of surpassing the highest resolving power yet reached. At Mount Wilson he had the co-operation first of J. A. Anderson and afterwards of F. G. Pease. A great success was quickly obtained with the double star Capella. Capella is a spectroscopic binary with a period of 104 days. It was known that the distance of its components must nearly approach the limit of visual detection, but attempts to observe it visually had failed. (I may remark that that is a rather controversial statement to make—particularly at the R.A.S.—but the controversy is now ancient history.) With two narrow apertures in the beam from the 100-in. mirror the fringes were observed and then brought to minimum visibility by varying the position angle and separation of the apertures. The changing position angle and distance were traced through the revolution. Anderson's measures, afterwards continued by Merrill, have given a very accurate orbit. The separation of the two components varies from 0·04″ to 0·05″. From a comparison of this visual orbit with the spectroscopic orbit we find the parallax of Capella and also the mass. The parallax is 0·063″, and the components are respectively 4·2 and 3·3 times as massive as the sun. The parallax does not differ much from that given by trigonometrical and spectroscopic determinations; but these were very rough values, whereas the interferometer parallax is presumably of the highest order of refinement. I suppose that the mass determinations are about the best we have for any star.[2] But what is especially important is that Capella is the *only giant star* for which we know both the mass and the absolute luminosity.

I may perhaps be allowed to refer to a personal interest in this first big result of Michelson's method. Capella now supplies the chief lacking constant in the radiative theory of stellar equilibrium, for which I had waited five years. It is, I think, generally conceded that the absolute magnitude of a giant star mainly depends on its mass, and theoretical formulæ can be found expressing the law of dependence. But we need to know one pair of corresponding values in order, as it were, to anchor the formulæ. Hitherto that correspondence could only be guessed roughly from statistical knowledge of the average luminosity of giant stars and an estimate of the corresponding average mass based on our general knowledge of the masses of stars (which, unfortunately, relates chiefly to dwarf stars). Having now the exact figures for Capella, we can substitute a precise determination

[2] The masses of α Centauri, Sirius, and Procyon may have about the same accuracy, but I do not think that any others reach this standard.

instead of the provisional estimate; the change is by no means unimportant, the original estimate having been considerably in error.

Capella would have been slightly beyond the theoretical resolving power of the 100-in. if used in the ordinary way, though an elongation might have been detected. Resolving power was actually gained by blocking out the mischievous central portion of the aperture. But now came the final step—to produce fringes with a greater path-difference than any telescope yet constructed could provide. In 1920 a 20-foot interferometer, designed by Michelson and Pease, was constructed, in which the two interfering apertures could be separated to a distance of 20 ft. This was used in conjunction with the 100-in. mirror, which helped to bring the two beams together to produce their fringes. One might say that Michelson was now employing a 20-foot mirror; only, since he was only intending to use two small areas at its edges, he economically constructed those particular areas and left the rest of the mirror to imagination.

On July 10, 1920, the great 20-foot beam was placed across the telescope. On December 13 success was attained, and the diameter of Betelgeuse was measured. Its interference fringes had totally disappeared when the mirrors were at 10 ft. separation, although the other stars showed them. The deduced diameter was 0·045″—about the same size as a halfpenny fifty miles away.

Michelson's visits to Mount Wilson were limited to the summer months, and he was not present when this result was obtained. When he returned in 1921 he found his collaborators much occupied in trying to find some plan of obtaining definite measures of the visibility of the fringes instead of vague judgments. He suggested the plan of using two apertures, one fixed and the other variable; a difference in the size of the apertures reduces the visibility to a definite extent, depending on the ratio of the two apertures. Finally, a comparison apparatus was constructed with one square aperture of 4 in. and the other a square variable from 4 in. to zero, in order to afford a definite scale of visibility.

In the early trials it took days to find the fringes, but as gradual improvements were made a few hours' work on the first night of a series of observations sufficed; the subsequent settings being made in a few moments.

I need only touch very briefly on later developments. Diameters of Antares, Aldebaran, Arcturus, and β Pegasi have since been measured. But, of course, the discs of most stars are far below the limits for a 20-foot instrument. Prof. Hale is now constructing a 50-foot interferometer, and it is estimated that thirty or forty stars will be within its grasp. There is no need for a large mirror, and the use of the 100-in. in conjunction with the first interferometer was rather a luxury. The 50-foot is of different design, and will not depend on any other telescope. All the diameters of stars measured up to the present confirm very closely the theoretical values that had been predicted for them. The enormous actual size of these stars—the earth's orbit could be placed entirely inside Betelgeuse—is a picturesque feature of the results; but that was a confirmation of facts already established almost beyond doubt.

It is not unlikely that interesting bypaths may be opened up. Considerable fluctuations in the diameter of Betelgeuse have been found, which may or may not be due to varying definition. The star is an irregular variable showing also changes of line-of-sight velocity, and the correlation of varying diameter with these other fluctuations would be of great physical interest if it turns out to be genuine. Michelson has pointed out that it is theoretically possible to determine by the interferometer the distribution of light over the disc—the law of darkening at the limb. That is a conceivable development for the future.

Sunlight and Disease.[1]

By Dr. C. W. SALEEBY.

"IN the beginning, God said, Let There Be Light." In or before the eighth century B.C., Zarathustra, foremost among many sun-worshippers in many ages, taught the cult of the sun and the green leaf and thrift, in place of pillage and murder. In the beginning of medicine, Hippocrates, practising at Cos in the temples of Æsculapius—son of Phœbus Apollo, god of the sun and medicine and music—practised the sun-cure. In the beginning of our era, Galen and Celsus used the sun. In the Dark Ages, by a pitiful misconception, the cult of the sun fell into desuetude as a species of pagan Nature-worship, and ill persons were treated alike in physical and in intellectual night. Tuberculosis and other ills were treated by the Sovereign touch, reputed to cure the "king's evil."

In the second half of the nineteenth century, we find certain heralds of the dawn. In 1856, Florence Nightingale vigorously but vainly protested against the orientation of Netley Hospital, observing that no sunlight could ever enter its wards. In 1876, Sir Benjamin Ward Richardson praised sunlight in his "Hygeia, The City of Health." In 1877, Downes and Blunt showed that sunlight will kill anthrax bacilli. In many writings at this period, John Ruskin upheld sunlight and declaimed against the "plague-cloud" of smoke above our cities. In 1890, Dr. Theobald Adrian Palm (*nat.* 1848), who still practises medicine at Aylesford, in the Garden of England, showed by the geographical method that lack of sunlight is the chief factor in the causation of rickets, and added an admirable series of recommendations accordingly.[2] His paper was entirely ignored, and I found it in America, thanks to an American bibliographer. Robert Koch and others showed that sunlight kills tubercle bacilli. In 1893, Niels Finsen began to cure lupus, a form of cutaneous tuberculosis, by the local use of sunlight, and Sir James Crichton-Browne made observations to the same effect in this country. In 1900, on May 1, the London Hospital

[1] From a discourse at the Royal Institution on March 9.

[2] "The Geographical Distribution and Ætiology of Rickets," *The Practitioner*, October and November 1890.

began the cure of lupus by the local use of sunlight, thanks to the really effective Sovereign touch of Queen Alexandra, who was instrumental in bringing her young fellow-countryman's idea from Copenhagen.

In 1903, Dr. A. Rollier opened at Leysin, in the Alpes Vaudoises, the first clinic for the treatment of so-called surgical tuberculosis by sunlight; and in 1910 he applied his idea to prevention by the establishment of the "school in the sun," at Cergnat, just below Leysin.[3] In 1914, he published his book, "La Cure de Soleil," but the world catastrophe of that year caused it to be overlooked. In this country his methods have been followed recently by Sir Henry Gauvain, at the Treloar Hospital at Alton and Hayling Island, where very simple sheds and solaria serve to achieve results never approached by Netley, the pretentious and misplaced architecture of which exists in the same county to point the contrast between its century—the last of the ages of darkness—and the dawn in our own. In a very few other places, also, such as the Queen Mary's Hospital for Children at Carshalton, under Dr. Gordon Pugh—photographs of which from the air show a series of three-sided solaria strongly resembling the health temple at Cos,—at Leasowe near Liverpool, at Perrysburg near Buffalo in the United States, and, following a recent lecture of mine, at the Heritage Craft Schools, Chailey, Sussex, the sun-cure is employed. At several others, which I have visited, the sun-cure is said to be employed, but is not, the elements of the matter being unknown to the persons in charge.

The results of heliotherapy, as seen in person, or recorded in Rollier's radiographic and clinical atlas of 1914, or shown by means of illustrations, are unapproached, for certainty, safety, ease, beauty, restoration of function, and happiness during and after treatment. No explanation of them, to be called intelligible or adequate, is offered by any of its practitioners. Being myself without patients or laboratories, I have used only the geographical method, and have found, at each place studied, a tendency to believe that the various factors there present are essential for the results obtained. In the mountains, altitude is insisted upon; at the sea, the argument for "helio-Alpine" is replaced by an argument for "helio-Marine." In high latitudes, the Mediterranean is described as impossible for sun-cure; on visiting the Mediterranean, I found the sun-cure gloriously successful on the French and Italian Riviera, and there are similar reports from Spain. The fundamental bases were lacking for a superlatively successful empirical practice, conducted by various clinicians under widely varying conditions and in ignorance, for the most part, of each other's methods. No rational statement of the scope of heliotherapy could be obtained, some strongly denying, while Rollier strongly averred, that tuberculosis is amenable to the treatment when it happens to be situated in the lungs, as it is amenable when situated elsewhere. In his volume of 1914, Rollier mentioned certain other conditions besides tuberculosis, such as rickets, a non-bacterial disease, but the only explanation of the sun-cure that he offered was based on the antiseptic action of sunlight, while Gauvain explicitly regarded the sunlight as only an adjuvant in his method.

Clearly the need was for a properly co-ordinated scientific inquiry into the action of sunlight upon the body in health and disease. We were using it as we used digitalis for the heart before pharmacology (to compare a great thing with one relatively trivial); we needed a true physio-pharmacology of this incomparable medicament. My demands (*e.g.* in NATURE, December 8, 1921, p. 466; January 5, 1922, p. 11) for such an inquiry were met, after six months, by the Medical Research Council, early in 1922, and from the date of the appointment of the Special Committee, under the chairmanship of Sir William Bayliss, a new chapter in clinical and preventive medicine, I believe, will be seen to begin, its provisional opening being the new and largely rewritten translation into English of "La Cure de Soleil,"[4] on which I resolved immediately after my first visit to Leysin.

Already we have at least made it clear to all critics that the action is due to the sun's light and not to its heat. So long ago as 1779, Ingenhouss showed that the dissociation of carbon dioxide by the green leaf is due to the sun's light and not to its heat. Yet, in several instances, the sun-cure has been tried, with calamitous results, by clinicians who, making no inquiry into the matter, have exposed the unaccustomed chests of phthisical patients to the mid-day sun, perhaps for an hour or two, with natural results in fever and hæmoptysis. Already, also, the idea that the light is less valuable in killing the infective agent than in raising the bodily resistance to it—an idea to which I invited attention nearly twenty years ago, at the death of Finsen—has come into the clinical mind. Since last August in the Light Department of the London Hospital—which has done such splendid though limited work on the older hypothesis, since 1900—the general light bath has been used as well as the local treatment, and cases which resisted the latter have been completely cured by general exposure of the nude skin to the electric arc lamp, without local irradiation. We must use a combination of light and cold, which I have been commending for some time on the evidence of visits to Canada, where a magnificent childhood, free from rickets, thrives in extreme cold, thanks, as I believe, to a brilliant sun.

In various American laboratories the subject is now being advanced: notably in Columbia University, New York, under Dr. Alfred F. Hess and his fellow-workers. They attribute the major part of the action of the sun to the ultra-violet rays, by which, in experimental animals and also in infants, they are able to cure rickets with great speed, ease, and certainty, and to increase very markedly the phosphorus in the blood of infants on a constant diet. When I saw this experimental and clinical work in New York last December, the result had already been reached of demonstrating an annual curve, from month to month, of phosphorus in the blood of infants, with a maximum in June-July, and a minumum in March, corresponding with the monthly height of the sun in New York. By radiographic study of the bones of infants, it had also been shown that no new cases of rickets occur

[3] The "school in the sun," in summer and winter, was demonstrated after the discourse by means of a film.

[4] "Heliotherapy," by Dr. A. Rollier, with forewords by Sir H. J. Gauvain and Dr. C. W. Saleeby. Oxford Medical Publications, 1923.

in New York in June-July, and the maximum number occur in March. Dr. Hess now informs me that the calcium content of the blood follows the same curve as the phosphorus content. Among earlier noted seasonal effects of sunlight, quoted by Hess in his latest paper, are the presence of increased iodine in the thyroid of cattle from June to November, and the greater resistance of guinea-pigs to aceto-nitrile poisoning in summer.

Hess and his workers have also begun the study of various clothing materials in this connexion, and find that they vary in their power of permitting or obstructing the action of light. Specimens of a mercerised cotton, one white and the other black, otherwise identical, the former allowing light to act and the latter interfering with it, have been examined by me, and I find no difference, due to the black dye, in the spacing between the fibres of the material. But I understand that the Department of Applied Physiology of the Medical Research Council has found, in a series of observations as yet unpublished, that the biological action of light can be graded by temperature. I am in hope that these specimens of material may be studied by the delicate methods associated with the name of Prof. Leonard Hill, and that it may be found that the black material produces a higher temperature than the white of the subjacent skin, thus prejudicing those unknown and beneficent chemical reactions which appear to need light and cold for their development.

The belief grows upon me that the asserted futility of heliotherapy in phthisis is due to the overheating of the patients in the sun. I think that a new chapter will open in the treatment of that disease when practitioners acquaint themselves with the principles and practice of heliotherapy before exposing their patients to the sun.

The power of sunlight and of cod-liver oil in rickets has suggested to Prof. Harden that the light may cause the skin to produce vitamin A for itself—though no instance of the synthesis of a vitamin by the animal body is known. The most recent work at the Lister Institute shows that light is unable to replace vitamin A completely, but appears to make a small quantity more effective. Miss Coward's work shows that vitamin A is present in the parts of flowers which contain carotin. Sir William Bayliss has suggested to me that the production of this vitamin in green plants is a function of the carotin rather than of chlorophyll, and that probably the carotin acts as a sensitiser for ultra-violet rays. In this connexion we must remember that pigmentation of the skin is a marked feature of the sun-cure, and that patients who do not pigment well do not progress well. No one who has seen and touched the typical pigmented skin of a heliotherapeutic patient can doubt that very active chemical processes are there occurring. Perhaps we should regard the skin less as a mere integument than as an organ of internal secretion. The pigmented skin under the sunlight is surely that; and we may ask whether it contributes, as Sheridan Delépine suggested,[5] to the making of hæmoglobin. I owe also to Sir William Bayliss the information that Dr. H. H. Dale, a member of his committee, has shown that smooth muscle can be made to contract by ultra-violet rays.

Aerial and other photographs of Manchester, and the Potteries, and of Sheffield, taken at successive hours on Sunday and Monday, demonstrate the obstruction of sunlight by our urban smoke, the industrial and the domestic chimney being both responsible: but while Sheffield deprives itself of more than half its sunlight, Essen is absolutely smokeless, and Pittsburg, which I have visited for the purposes of this inquiry, has abolished 85 per cent. of its smoke. Sections of the lungs of an agricultural labourer and a typical urban inhabitant of our country, the latter being heavily infiltrated with smoke, illustrate a cognate aspect of our subject.

Yet another point is illustrated by recent work of Hess, which shows that the milk of cows fed on pasture in the sunlight maintains the growth and health of young animals, whereas the milk of cows fed in shadow and on vitamin-free fodder will not maintain life. Our children are thus disadvantaged in winter by light-starvation, and by the defect of the milk of light-starved cows.[6]

Photographic study of houses and housing on both sides of the Atlantic illustrates the problem of urban light-starvation. Finding New York smokeless in 1919, I later made investigations with the aid of Dr. Royal S. Copeland, the Health Commissioner of that city, and found that the death-rate from pulmonary tuberculosis had been reduced by one-half in the period, 1905–1919, of the operation of the sanitary regulation against smoke.[7] The restoration of sunlight to our urban lives is the next great task of public health in this country.

"There is no darkness but ignorance," as Shakespeare said. In every sense we need "more light." Then we must apply our knowledge, less for heliotherapy than heliohygiene, until we have banished what I call the diseases of darkness, and it may be said of us that "The people that walked in darkness have seen a great light, and they that dwell in the land of the shadow of death, upon them hath the light shined."

[5] *Journal of Physiology*, vol. xii., 1891, p. 27.

[6] To some extent, Antipodean sunlight, in the form of dried milk from New Zealand, comes to the rescue.

[7] The smoke prohibited in New York, or in Winnipeg, where I found similar regulations, need not, as in our futile Public Health Act, be "black." See "The Eugenic Prospect" (Part II., "Let There Be Light"), by Dr. C. W. Saleeby. (Fisher Unwin, London; and Dodd Mead and Co., New York, 1921.)

Domestic Animals in Relation to Diphtheria.

THE perennial alarm of the possible transmission of diphtheria from diseased animals to man is again occupying the attention of the British daily press. This time it arose out of the death of a little girl who was thought by her mother to have contracted diphtheria from certain chickens which were kept in the house. The mother's view was supported by a medical man, who said that birds are subject to the germs of diphtheria and die of the disease. He had no doubt also that dogs and cats could have diphtheria, and he knew of instances of pigeons which had it.

The present writer has recently made an exhaustive critical analysis of the literature on this subject, and can state definitely that this bird, cat, and dog story is a pure myth. Diphtheria bacilli have been found on three occasions in cows (cases of Dean and Todd (1902), Ashby (1906), and Henry (1920)), and by two authors (Cobbett (1900) and Minnett (1920)) in horses. No proved diphtheria bacilli have ever been found occurring spontaneously in cats, dogs, or fowls. In 1920 Simmons obtained, from two cats, bacilli resembling diphtheria bacilli in man, but differing in the fundamental respect that they fermented cane sugar, which human diphtheria bacilli do not.

The belief that cats are frequently capable of transmitting diphtheria arose in Great Britain largely out of work done by E. Klein for the Local Government Board in 1889 and 1890. He based his opinion on the existence of spontaneous diphtheria in cats on the fact that a very fatty condition was found in the kidneys, a lesion which he regarded as pathognomonic of the disease in this animal. Before Klein published this statement it was already well known (Gluge (1850), Handfield Jones (1853), and Beale (1869)) that all normal cats show this lesion—a fact confirmed by modern writers like Hansemann (1897), Fibiger (1901), and Mottram (1915–16). In an extensive inquiry in 1919–20, Savage was unable to find, nor could any one produce, a cat infected with diphtheria bacilli.

The doctrine of milk-borne diphtheria was also largely based on Klein's work (1890). He alleged that when cows are injected with cultures of diphtheria bacilli in the shoulder, these diphtheria bacilli appear in the milk and the animals suffer from an eruptive disease of the udders and teats. Dean and Todd (1902) traced a milk-borne epidemic of diphtheria to cows with scabs on the udders. They showed that the eruption was not due to diphtheria, and they regarded the diphtheria bacilli found in the udder as a superposed infection from the saliva of an infected milker. In 1920 Henry studied an epidemic of thirty-two cases. The disease was traced to milk. The dairy-maid was found to be suffering from cutaneous diphtheria, and from her the udder became affected, this in turn transferring the disease to the hands of the maid's father.

So far as is known, these are all the positive facts of the animal transmission of diphtheria to man. We may therefore assume that it is an event of exceeding rarity. With regard to birds there is no proved instance that these animals have ever transmitted the disease. So-called croup and diphtheritis in birds have nothing to do etiologically with human diphtheria. It is not necessary to assume an animal origin of an outbreak of diphtheria until all possible human sources in the immediate neighbourhood have been excluded. This can be done only by cultivations, and not by the pious opinions of mothers and medical men without experience in bacteriology.

W. B.

Obituary.

Prof. E. Majewski.

The late Prof. Erazm Majewski, the Polish naturalist, who died on November 15 last in Warsaw, was a scholar and pioneer worker of a type characteristic of the difficult and discouraging conditions in pre-War Poland—a country divided by three alien states, two of which forbade the use of the native language, even in the primary schools, excluded native teachers, and suppressed native culture.

Born in 1858, in the provincial town of Lublin, Prof. Majewski studied science at the University of Warsaw. In order to devote himself to research, to which he had felt attracted from earliest youth, he had first to gain a financial independence, for at that time there were no endowments, no academic positions, no possibilities of scientific publication for a Pole who wanted to work in his own language and for his own country. Prof. Majewski took up and developed an important branch of chemical industry and thus obtained a living at first, and afterwards what, for Polish conditions, might be considered a small fortune. With this he could not only find leisure for his own research, which soon became very strenuous and extensive, but he also was able to finance research and help a number of younger students.

Prof. Majewski's own activities were astoundingly multifarious: translations into Polish, popular expositions, manuals, monographs, scientific novels, treatises, and last, not least, solid original contributions, partly based on research in the laboratory and in the field. The subjects of his work were commensurately extensive: chemistry, botany and geology; later on, ethnography, prehistory and archæology; finally, in the last ten years of his life, economics, sociology, and history of civilisation. Perhaps the most lasting value will be retained by his archæological and prehistoric studies, through the impetus which he gave to excavation and collecting, through the foundation of an excellent periodical (*Swiatowit*), which he financed and edited himself, and through the formation of a large and valuable collection of Slavonic archæology, presented in 1921 to the Scientific Society of Warsaw.

All Prof. Majewski's work reveals a man of genius in the marvellous grasp of each problem touched upon, in the original and independent point of view, in the amazing power of study and assimilation. It shows, of course, also the defects of its qualities: such enormous output over a wide range is bound to entail a certain degree of dilettantism, many hasty generalisations, and a tendency to avoid all negative evidence. All the defects of the late Prof. Majewski's work, however, are due mainly to the unfavourable conditions under which he worked: absence of scientific organisation, of co-operation and of division of work, all of which leads to the unlimited pegging out of claims over the vast territory of science by an enterprising and independent mind, to lack of self-criticism, to an easy lapsing into over-ambitious schemes. The qualities which he possessed, on the other hand, are native and intrinsic to his own mind, and entitle us to hope that his country, which can produce such people as he under the most discouraging conditions, will, when its political and economic foundations are once more secure and its scientific work organised, be able to contribute its due share to the progress of science.

B. M.

Dr. Hartwig Franzen.

On February 14 the death occurred at Karlsruhe, Baden, of Dr. Hartwig Franzen, extraordinary professor of organic chemistry at the Technical High School.

Hartwig Franzen was born on March 21, 1878, at Nortorf, Holstein; he studied at Heidelberg, Berlin, and Copenhagen, graduating in 1901 at Heidelberg and becoming a private lecturer in chemistry at that university. His first work was published in collaboration with Th. Curtius, the discoverer of hydrazine and hydrazoic acid (azoimid), whose favourite pupil he was. In 1910 he became extraordinary professor and was called in 1912 to the Technical High School at Karlsruhe as sub-director of the organic chemistry institute. Franzen worked on gas analysis and embodied his results in his "Practicum," which was published in 1907. He also investigated the hydrazine compounds and problems in the chemistry of fermentation and the physiology of plants. Many of his publications deal with the constituents of green plants. Franzen was a well-known investigator and an efficient teacher. His early death leaves a great gap in the ranks of the younger German chemists, and his numerous friends and pupils will faithfully preserve his memory.

We regret to announce the following deaths:

Mr. F. W. Harmer, for more than fifty years a fellow of the Geological Society and well-known for his studies of Pliocene mollusca, on April 24, aged eighty-seven.

Prof. G. D. Hinrichs, formerly professor of physical science in the University of Iowa and of chemistry at the St. Louis College of Pharmacy, aged eighty-six.

Sir Albert J. Hobson, pro-chancellor of the University of Sheffield and for twenty years a member of the council of the University, on April 20, aged sixty-one.

Prof. V. Th. Homén, Pippingsköldsche professor of applied physics in the University of Helsingfors, aged seventy-five.

Dr. A. Latham, physician and lecturer in medicine at St. George's Hospital, who was known for his work on pulmonary consumption, on April 13, aged fifty-six.

Prof. E. W. Morley, professor of chemistry at Western Reserve University from 1869 until 1906 and known for his part in the Michelson-Morley experiment to detect motion of bodies through the æther, aged eighty-five.

Sir John Watney, chairman of the Council of the City and Guilds of London Institute, on March 25, aged eighty-nine.

Mr. J. Wright, well-known for his work on Irish foraminifera and carboniferous fossils, on April 7, aged eighty-nine.

Current Topics and Events.

The "Zoological Record," which for nearly sixty years has annually supplied zoologists with bibliographical references to the literature of their subject, and in particular has performed the task of recording the names of new genera and species introduced each year, is threatened with extinction. Although the responsibility for producing the Record was temporarily shared with the International Catalogue, which has ceased to exist, the credit for its publication, during recent years, has otherwise belonged exclusively to the Zoological Society, which has thus earned the gratitude of workers in all parts of the world. The decision of the council of the Society to cease publication, except on certain terms which are explained in another part of this issue, will be received with regret and consternation by a large number of investigators. It is urgently necessary that a combined effort should be made to save this invaluable serial, and those interested are invited to communicate with Sir Sidney Harmer, at the British Museum (Natural History). Suggestions will be welcomed, but it is hoped that many will be able to express their sympathy in a practical form, by undertaking to subscribe for the annual volumes or for the separate parts in which they are individually interested, or by giving assistance of an even more direct nature.

The treatment of diabetes by the use of the extract of the pancreas known as "insulin" is now made more widely possible by the fact that it has been put upon the market by the British Drug Houses in conjunction with Messrs. Allen and Hanburys, Burroughs, Wellcome and Co., and Eli Lilly and Co. On account of the limited supply as yet available, the Medical Research Council has made certain recommendations to the Ministry of Health with regard to its economical use. The Minister has appointed the following committee to advise him on the subject: Sir George Newman, Dr. R. A. Bolam, Sir Walter Fletcher, Sir Humphry Rolleston, Dr. Alfred Salter, and Dr. McCleary. This committee, which can be addressed at the Ministry of Health, Whitehall, has recommended that insulin should be supplied only to hospitals and medical practitioners who have at their disposal means of determining the sugar content of the blood. Those to whom the preparation is supplied shall undertake to make observations of the changes in the amount of sugar in the blood in correlation with the dose of insulin given. It shall not be given where the symptoms can be controlled by moderate restriction of diet. It may, however, be given in coma, as an emergency treatment, or in preparation for a surgical operation. Detailed instructions for its use and for obviating the results of too large a dose are supplied by the makers with each sample.

A member of an Indian Provincial Legislative Council was reported recently to have demanded that the budget allotment for combating hookworm disease should be cut out because, as ninety per cent. of the people suffered from this serious disability, "it was a normal state of health and there was no meaning in spending money on investigation and prevention of the disease." The demand revealed a dangerous depth of ignorance, or, what is worse, a perversion of knowledge—for the speaker was an Indian doctor—which is only equalled by that of another member asking not long ago what steps a Provincial Government proposed to take to diminish the deaths due to lightning! Unfortunately, the Retrenchment Committee has recently recommended decentralisation of medical research in India, with consequent dependence of all grants for its support being voted annually by the large Indian Council majorities. The qualifications for such serious responsibility can be gauged by the above examples, and they are combined with administration by an Indian Minister who is very unlikely to look beyond his own province and race for research workers. Moreover, the original grant of five lakhs of rupees (33,000*l.*) a year for medical research was cut down to 3½ lakhs during the War, and is now recommended to be abolished. In its place the 33 lakhs accumulated by the Indian Research Fund Association during the War, and ear-marked for a new research laboratory in Delhi, is to be capitalised to bring in about two lakhs a year for the full support of the bacteriological department, which is to be deprived of twelve of its officers—more than one-third of the total number—the whole savings from this small department being disproportionally great as compared with many far less valuable and life-saving forms of expenditure. The future of medical research in India will be dark indeed if such large reductions in finance and personnel are effected, and still more so if the remaining funds are to be placed at the mercy every year of the large Indian majorities on all the Provincial Councils, few of whom have had the slightest scientific knowledge or training.

The first congress of Polish Chemists and Physicists met in Warsaw on April 3. With a total membership of about 850, this meeting has taken a high place among recent Polish scientific congresses, and the organising committee is to be congratulated upon the brilliant success achieved. A large gathering of scientific and industrial chemists and physicists, together with representatives of the Government, the Municipality of Warsaw, and of various societies and corporations, filled the Great Hall of the Technical High School of Warsaw on April 4, when the meeting was welcomed by Dr. Mikulowski Pomorski (Minister of National Education), and short scientific addresses were delivered by Prof. Ladislas Natanson (Rector of the Jagellonian University of Cracow), and by Profs. Marchlewski, Bialobrzeski, and Moscicki. The scientific proceedings of the sections were full of interest; about 120 papers were read in various chemical sections and about 36 in the section of physics; there were many communications showing serious work and real progress. Particularly interesting, in the section of physics, were communications by Profs. Pienkowski, Zakrzewski, Wolfke, and Reczynski on experimental investigations in progress in various University laboratories in Poland. The meeting concluded on April 6 with an address delivered by Prof. Tolloczko, and the usual votes of thanks. The hearty reception accorded to scientific men coming from all parts of Poland was much commented upon by those who attended this very successful meeting.

The first conversazione of the Royal Society this year will be held at the Society's rooms, Burlington House, on Wednesday, May 16.

The *Times* announces that the Anthropological-Geographical Society of Stockholm has conferred the Anders Retzius Medal in gold upon Sir Aurel Stein for his archæological research in Central Asia.

The twenty-ninth James Forrest lecture of the Institution of Civil Engineers will be delivered on May 4 by Sir Richard Glazebrook, who will take as his subject "The Interdependence of Abstract Science and Engineering."

Dr. H. H. Dale will deliver two Oliver-Sharpey lectures at the Royal College of Physicians of London on May 1 and 3, at 5 o'clock, taking as his subject "The Activity of the Capillary Blood-vessels, and its Relation to certain Forms of Toxæmia."

The Adolph von Baeyer Memorial lecture will be delivered before the Chemical Society by Prof. W. H. Perkin, in the Lecture Hall of the Institution of Mechanical Engineers, Storey's Gate, S.W.1, on Thursday, May 10, at 8 p.m.

The Secretary for Mines has appointed the following to be additional members of the Safety in Mines Research Board: Prof. W. S. Boulton, Prof. S. M. Dixon, Dr. J. S. Haldane, Prof. C. H. Lees, and Prof. J. F. Thorpe.

The Chemical Society Research Fund Committee will meet early in June. Applications for grants should be made on forms obtainable from the Assistant Secretary, Chemical Society, Burlington House, Piccadilly, W.1, and must be lodged with the Assistant Secretary by June 1.

Applications for grants in aid of scientific investigations bearing on agriculture to be carried out in England and Wales during the academic year beginning on October 1 next should reach the Secretary, Ministry of Agriculture and Fisheries, Whitehall Place, S.W.1, by, at latest, May 15. The applications must be made upon form A. 230/1, copies of which can be obtained from the Secretary to the Ministry.

Applications are invited by the Ministry of Agriculture and Fisheries for a limited number of research scholarships in agricultural and veterinary science, tenable for three years and each of the annual value of 200*l.* The latest date for the receipt of applications, which must be made upon a prescribed form, is July 15. The form and particulars concerning the conditions of the scholarships are obtainable from the Secretary, Ministry of Agriculture and Fisheries, Whitehall Place, S.W.1.

An election of not more than six junior Beit Memorial fellows for medical research will take place in July next, and the persons elected will be required to begin work on October 1. Each fellowship is of the annual value of 350*l.*, and the usual tenure is three years. The latest date for the receipt of applications is June 1, or, in the case of candidates giving residents abroad as referees, May 15. Forms of application and all information may be obtained by letter only addressed to Sir J. K. Fowler, Honorary Secretary, Beit Memorial Fellowships for Medical Research, 35 Clarges Street, W.1.

Dr. Edward P. Hyde, who organised the Nela Research Laboratories in 1908, and for the past few years has occupied the position of director of research of the National Lamp Works of the General Electric Co., Cleveland, has tendered his resignation, to take effect on June 30. Dr. Hyde, who has been active in scientific and technical affairs for a number of years, has decided to take a prolonged rest abroad. He will temporarily discontinue many of his activities in scientific and engineering societies, but will retain the office of president of the International Commission on Illumination until its plenary meeting, to be held in the United States in 1924.

In connexion with Dr. Simpson's Royal Institution discourse on "The Water in the Atmosphere," published in Nature of April 14, Prof. A. W. Bickerton writes to suggest an alternative formation for hailstones which have the form of cones mounted on hemispherical bases. It is suggested that these may be formed by the freezing of raindrops which solidify first on the outside, then, as the core freezes, the expansive pressure bursts the spheres along the lines of minimum resistance, these being the lines of a pentagonal dodecahedron. The difficulty of this explanation is that soft hail, to which reference was made by Dr. Simpson, forms above the region where raindrops are met with. Also the "stones" of soft hail are frequently so large that the mass of twelve of them would be much greater than the mass of the largest possible raindrop—which has a diameter of less than half a centimetre.

The Gifford Lectures delivered in 1922 by Prof. C. Lloyd Morgan will shortly be published by Messrs. Williams and Norgate under the title of "Emergent Evolution." Among the chapter headings are the following:—emergence, mental and non-mental, relatedness, reference, memory, images, towards reality, vision and contact, relativity, causation and causality, and evolutionary naturalism.

Messrs. Sotheran's Catalogue of Science and Technology is always of bibliographic interest and value, being carefully classified, and containing informative annotations to many rare volumes offered for sale by the publishers of the catalogue. The latest part is No. 783, dealing with mathematics. It should be seen by all who take an interest in the subject. The catalogue is obtainable from H. Sotheran and Co., 140 Strand, W.C.2.

Our Astronomical Column.

The Planet Jupiter.—This planet will arrive at opposition to the sun on May 5, when its distance from the earth will be about 410 millions of miles. It is now visible during the whole night, and is favourably situated for telescopic examination. The Great Red Spot in the southern hemisphere remains faintly visible, and a slight increase in its rotation period has occurred in the last few years. Its present longitude is 228°, so that it precedes the zero meridian of System II. by about 3 h. 38 m. Observations of the transits of this marking will be valuable, and may be witnessed at about the following times:—

	h.	m.			h.	m.	
April 29.	8	47	G.M.T.	May 8.	11	6	G.M.T.
May 1.	10	21	,,	,, 11.	8	37	,,
,, 3.	11	59	,,	,, 13.	10	15	,,
,, 6.	9	28	,,	,, 18.	9	22	,,

The extensive dusky marking, known as the south tropical disturbance, is now in contact with the following end of the Great Red Spot, and it will be interesting to watch this object, as it passes the Red Spot in ensuing months.

From recent observations by Mr. F. Sargent of the Durham University Observatory, it appears that the rotation period of the south edge of the South Equatorial belt of Jupiter shows an abnormal period of $9^h\ 52^m\ 37^s$. This latitude on Jupiter falls between the two well-known currents, on which Systems I. and II. were based, the periods being $9^h\ 50^m\ 30^s$ and $9^h\ 55^m\ 40{\cdot}6^s$ (Nautical Almanac, 1923, p. 568-71).

The unusual time of rotation was derived from a mean of three markings, but the observations extended over too short an interval to obtain exact results. There is no doubt, however, that there is an intermediate current between that in which the Great Red Spot is situated and the equatorial markings, and it will be important to follow the objects seen by Mr. Sargent which on March 29 were in longitudes from 309·7° to 325·1° (System I.).

Spectra of Three O-type Stars.—Dr. H. H. Plaskett contributes to the Publications of the Dominion Astrophysical Observatory (vol. 1, No. 30) an important research on the spectra of three O-type stars. These stars show enhanced line spectra which can only be reproduced terrestrially under extreme conditions of excitation. Their spectra thus afford an opportunity for testing theories on the origin of spectra and for ascertaining some of the physical conditions in stellar atmospheres. The stars in question were 10 Lacertæ (Oe 5), 9 Sagittæ (Oe 5) and B.D. 35° 3930 N (Oe) and their spectra were secured with the universal spectroscope attached to the 72-inch reflector using one-, two- and three-prism dispersion. Dr. Plaskett first points out that if the Pickering lines (ζ Puppis) are due to enhanced helium, Bohr's theory predicts the existence of enhanced helium components about 2Å to the violet of the hydrogen lines. He then gives his evidence for showing that those predicted components are present in his spectra, which demonstrates that the Pickering lines and λ 4686 are due to enhanced helium.

In two of the stars Dr. Plaskett employs the mean wave-lengths of the enhanced helium lines for the determination of the value of the Rydberg constant N_2 for helium, and deduces the values of Planck's constant and the mass and charge of the electron. Those values he compares with recomputed values from Paschen's value of N_2 and with results from other methods of determination. He deduces the temperatures of the O-type stars under discussion and gives the following values: 9 Sagittæ, 18,500° K; 10 Lacertæ, 15,000° K; and B.D. 35° 3930 N, 22,000° K. He finally suggests a modification of the Harvard Classification of the O-type stars as follows:

Class Oo, Pickering lines disappeared; Class O5, (B.D. 35° 3930 N) ordinary helium disappeared; Class O7 (9 Sagittæ) Mg +, 4481 missing; Class O9, Si III +, pair 4552, 4567, on the point of appearing.

Research Items.

Excavations at Ancient Carthage.—A correspondent writing in the *Times* of April 9 describes the result of excavations on the site of ancient Carthage conducted by a party of Americans working in co-operation with French archæologists. Their work is timely, as the site of this city is in danger of becoming a modern suburb of Tunis. Within the city itself the remains of two sanctuaries and the potters' quarter have yielded some sculptured stones and numerous specimens of pottery. But the most important discovery is an underground corridor through which a supply of water passed, and some rock-cut tombs, containing statues, two on recumbent stone coffins of Greek work, and others showing that the Carthaginians were dependent for their art on Greece and Egypt. It is hoped that further exploration will throw light on the Roman buildings and North African architecture during the Christian period.

Clash of Ideals in Modern India.—The Earl of Ronaldshay, Governor of Bengal, 1917–22, delivered an interesting address before the Indian Section of the Royal Society of Arts, which is printed in the Society's Journal (vol. lxxi., No. 3, 665), on the situation in India. The motive force of the native movement is " fear lest before the triumphant assertiveness of Western civilisation all that is essentially and distinctively Indian is doomed to perish and utterly to disappear." As regards education, there is dissatisfaction with the present system, but it is not easy to discover what it is that Indians desire to see taking its place. There is an emphatic demand for vocational or practical instruction—they object to the present courses as displaying a Western bias; the demand in Bengal for medical training is clamorous and widespread, " and many Indians who are far from being hostile to the British connexion desire to see a more distinctly Indian orientation given to the education imparted to their people." The address, which deserves attention, takes, on the whole, an optimistic view of the present situation.

Psychology and Criminal Responsibility.—In *Psyche* (vol. iii., No. 2) Dr. W. Brown discusses the attitude of modern psychology to responsibility. He shows that there is a tendency for those who understand incompletely the aims of modern psychology, to believe that a general spread of its doctrines will result in a weakening of the sense of moral responsibility. He discusses the legal definition of responsibility and describes cases where a crime of violence may be committed for which the person cannot be held responsible. The psychologist, as such, is concerned with the problem of studying the causes in the history of the person which have led to the act, and the contribution of recent work is in the direction of tracing the influence of the acts and phantasies of infancy and childhood; it appears not infrequently that the people answerable for the victim's upbringing were really responsible. Modern psychology does not contest the reality of moral responsibility. While it holds the view that criminals suffering from certain forms of mental disease are less fully responsible than are normal people, it does not countenance the view that all criminals suffer from mental illness, nor that mental illness is an invariably sufficient excuse for crime.

The Alphabet used in Writing Malay.—There is no record of the Malay language having been written until the Arabs reached Indonesia, the oldest existing documents being written in the Arabic character, which is still largely used. After the Arabs came the Portuguese, Dutch, and English, and each nation adopted its own system. It has been felt for a long time that it would be a convenience if a uniform system of spelling were adopted. Hitherto the choice has lain between Arabic characters and the Dutch or English spelling, none of which are quite satisfactory. Mr. C. H. Pownall in a pamphlet entitled " The Writing of Malay " (Cambridge, W. Heffer and Sons, Ltd.) suggests that the system known as " Peetickay," advocated by Dr. W. Perrett in a book issued by the same publishers in 1920, should be adopted. It possesses the special advantage that those who suffer from writer's cramp find it a great relief, as the pen is more frequently raised from the paper than in ordinary writing. Mr. Pownall regards this system as preferable to the symbols used by the International Phonetic Association: but it does not seem probable that a conservative oriental race will be inclined to adopt a new system instead of the systems to which they are accustomed. In the end, in spite of certain difficulties, English will hold the field.

The Laws of Vision and the Technique of Art.—In his treatise on landscape painting, Birge Harrison shows that a picture is most artistic when it reproduces our retinal impressions, and his theme has been taken up and developed by Messrs. A. Ames and C. A. Proctor and Miss Blanche Ames in an interesting paper published under the auspices of the Rumford Fund in the February issue of the Proceedings of the American Academy. The retinal picture is less distinct at the edges than at the centre and is distorted in the " barrel " manner, while the retina itself is more sensitive to blue near the edge than at the centre. When a photograph of a landscape or building taken with a camera having a lens with the same properties as the eye is compared with one taken with a corrected lens, that taken with the artificial eye produces the more artistic effect. On examining a number of pictures by distinguished artists, the authors have found evidence of the use—conscious or unconscious—of the technique suggested by these laws of vision by da Vinci, Rembrandt, Israels, Millet, Turner, Whistler, De Hoogh, and others, but only by one living artist—Orpen. The authors urge that the retinal picture should be made the basis of the technique of art.

Classification of Cirrus Clouds.—In *Geografiska annaler*, 1922, 3-4, Mr H. H. Hildebrandsson has a short paper in which he discusses an international terminology for the various kinds of cirrus clouds. After full consideration of the forms of cirrus described by L. Besson, C. J. R. Cave, A. W. Clayden, C. Ley, J. Loisel, l'Abbé Maze, H. Osthoff, and J. Vincent, all the classifications of whom are summarised, Mr. Hildebrandsson proposes seven main types. Some of these are rare and none is common in its typical form, but they serve as a basis of a classification to which all cirrus can be referred. The seven types, each of which is briefly described and in many cases illustrated, are uncinus or caudatus, vertebratus, pennatus, filosus, confertus, floccosus, and nebulus. The names have the merit of being indicative of each type, and are easily remembered. The classification certainly seems to be sounder than some former ones which recognised a dozen or more main types.

Climatological Normals for Egypt and the Sudan.—The Physical Department of the Ministry of Public Works, Egypt, has issued a book of normals which comprises 63 stations, and in addition to the Egyptian and Sudanese stations, it includes seven stations in Cyprus, one in Crete, and one in Abyssinia. Many of the normals cover a period of 20 years. Normals for rainfall are given for 76 stations, for the total number of years for which trustworthy records are available. It is said not to be uncommon, especially in the Sudan, for the relative humidities to fall below 10 or even 5 per cent. Wind force given throughout is stated to be in terms of numbers on the Beaufort scale. The scale is given as 0–10, but Beaufort scale should be 0–12. The equivalents in miles per hour given for the scale 0–10 is in fair agreement with the Beaufort values 0–10 given by the British Meteorological Office. The percentage frequency of wind direction is given for most stations. Most of the Egyptian stations have single louvred screens; this seems scarcely satisfactory, especially for a hot country. Monthly maps are given for isobars and prevailing winds, for air isotherms, and for rainfall. The tables of normals are of great value to the world's meteorology. The absolutely highest temperature on a single day at many stations exceeds 120° F. and in places even touches 130° F. On the coldest day in winter frost is exceptional in the shade to the south of 20° N. Rainfall for a single day is occasionally more than the average total fall for the month; there are two instances of 11 inches and more in the 24 hours—at Alexandria in December 1888 and Tombé in the Sudan in July 1914. A rainfall map intended as a frontispiece will be issued separately.

PEAT IN THE UNITED STATES.—Though peat is still looked on with hesitation as a source of industrial fuel in the near future, every national geological survey is attracted by the numerous schemes for its exploitation. That of the United States has issued Bulletin 728, on "The occurrence and uses of Peat in the United States," by E. K. Soper and C. C. Osborn (1922). The maps record very considerable deposits in the regions of more temperate climate, as in Minnesota towards the Canadian border. It is pointed out that, contrary to popular belief, the Mississippi basin is poor in peat, owing to the high temperature, which accelerates the decay of vegetation, and the frequent floods, which deposit sheets of alluvium. Some of the plates illustrating the infilling of basins of various types introduce unusual scenes, such as the Dismal Swamp, with its decaying forest, in the Virginian coastal plain. When we come to the treatment of peatlands for raising crops, we find that the customary advice is given, to clear away the upper peat as much as possible, to drain thoroughly, and to add materials that will provide the land with something like a reasonable soil. The case is familiar to us through agriculture in the English fenlands. The Bulletin forms a good handbook for the appreciation of lowland peat-deposits by the student.

GENETICS OF PRODUCTIVITY.—In a study of productiveness in apple trees, Sax and Gowen (Bull. 305, Maine Agric. Expt. Sta.) show that this quality is closely associated with habit of growth, although soil differences in an orchard also play a part. They also show (Bull. 307) that many commercial varieties of apples are self-sterile and that insect visits are essential for the setting of fruit. They recommend the interplanting of different varieties which are inter-fertile and flower at the same time. In two other papers (Bulls. 301 and 306) on milk production in Holstein-Friesian cattle, a further study is made of the transmitting powers of sires for milk production, and of the relative merits of a 7-day or a 365-day test for the relation between milk yield and percentage of butter-fat. That the daughters of different sires inherit differences in their milk production is well known. But pedigree results show that the cattle breeder's principle that "like begets like" is not a sufficient one to follow in breeding for milk production.

MOULDS ON MEAT IN COLD STORAGE.—On behalf of the Food Investigation Board, F. T. Brooks and M. N. Kidd recently published, in Special Report No. 6 of the Board (1921), an account of the "black spot" produced upon meat in cold storage by the activity of moulds. In this report it was demonstrated that the moulds responsible for the discoloration could grow and reproduce, although the meat was kept at −6° C. F. T. Brooks and C. C. Hansford have now published the more interesting mycological results of this valuable piece of applied research in the Transactions of the British Mycological Society, vol. 8, Part III., pp. 113-142, 1923. They conclude that *Cladosporium herbarum* is the species responsible for all the cases of "black spot" on meat they have observed, and that *Hormodendron cladosporiodes* is identical with it. This Cladosporium appears to occur very generally on vegetable refuse as well as on meat, and to be very variable in habit, so that a careful control of its structure and growth on a wide range of culture media is necessary for its identification. Many of its forms appear to have been described as species. Among the other moulds growing on cold stored meat two new species, *Sporotrichum carnis* and *Torula botryoides*, have been isolated; while on one occasion a new genus turned up in a woolly patch of mould present on a consignment of skinned Australian rabbits. In view of the laboratory from which the present work is issued, it is appropriate that the authors have named the new genus Wardomyces in memory of the late Prof. Marshall Ward.

THE SPREAD OF RUSTS UPON CEREALS.—With work proceeding for the new Ph.D. degree at many British Universities, we shall probably have many theses published in which essentially British problems are materially elucidated by overseas investigators. Certainly Karm Chand Mehta, now professor of botany at Agra College, India, as a result of his work at Cambridge under the direction of Mr. F. T. Brooks, has given us a most valuable study of the methods by which cereals are attacked year after year by the various species of the rusts (now published in the Trans. Brit. Mycological Soc., vol. 8, Part III., pp. 142-176, 1923). The rusts are quite unable to grow as saprophytes, hence there is great difficulty in their continued maintenance in pure culture, and much discussion as to the method by which these fungi maintain themselves through the winter when their normal host plant is harvested in the autumn. These parasites were some of the first microscopic forms in which a well-marked life cycle was traced with essential stages in two separate host species, often plants of widely different nature, and in the case of the black rust of wheat, *Puccinia graminis* Pers., the present paper supplies further evidence for the truth of an oft-contested thesis that the wheat plants may be infected from the accidial stage upon the winter host, the wild barberry. In the case of the other rusts of wheat, brown rust, *P. triticina* Erikss., and yellow rust, *P. glumarum* Erikss. and Heun, the observations and experiments here recorded show the significance of the self-sown seedlings of the wheat left in the ground after the harvest; upon these the fungus persists and the uredospores formed upon them are the main source of infection of the new crop. This paper, as some earlier classic papers from the Cambridge laboratory, is fundamentally opposed to the point of view of the great Scandinavian mycologist Eriksson, who has assumed that the fungus must persist through the life-cycle of the host plant as an undetectable protoplasmic contamination, "mycoplasm," intermingled with its own living substance.

Artesian Water in Australia.—In the report for 1921 of the Director of Mines and Government Geologist for South Australia, there is included a useful map of the principal artesian basins of Australia, made in connexion with the interstate conference on artesian water which met at Adelaide in September 1921. The map is of special interest in showing the isopotential lines or the heights above sea-level to which the water will rise. These lines have been accurately determined in many parts of the great artesian basin, especially in New South Wales and Queensland. They are less certain in parts of South Australia, but they are sufficiently accurate to show the absence of any concealed south-westerly outlet. The basin as a whole has marginal intake beds surrounding it. Fragmental isopotential lines for the Murray river basin have been embodied in the map. The scale of the map is too small to allow detail in the case of the basins of Willochra valley, Port Pirie, Cowell, and Adelaide plains. There is a lack of information in the case of the Eucla basin, but from the variable salinity of the water it would seem to be derived from more than one source in the sandy desert.

Generalised Optical Law.—Part 1 of volume 24 of the Transactions of the Optical Society contains the generalised optical law communicated by Mr. T. Smith to the Society in December last and called by him the optical cosine law. It includes as special cases the law of refraction, the coma sine law, the axial displacement and other exact laws of optical instruments, and runs thus: If I is the angle of inclination of a ray to a chosen fixed direction in the object space and I′ the inclination of the emergent ray to a chosen fixed direction in the image space, then the rays for which $\cos I = p \cos I' + q$ where p and q are constant touch caustics S in the object and S′ in the image space, and if S be displaced a small distance s along the fixed direction in the object space to S_1 the image caustic S′ will move along the fixed direction in the image space through a distance s', where $n's' = nsp$ and n n' are the refractive indices of the object and image media. The application of this generalised law to the construction of a telescope aplanatic at all magnifications is given as an illustration.

Wind Steadiness in the Upper Air.—To the March number of the *Meteorological Magazine* Mr. H. Harries contributes some curious facts about the flights of toy balloons in "races" organised by Major MacLulich at Brighton during the summer of 1922. On August 23 two balloons were liberated together, and next morning they descended in the little village of Marcel par Vitrey, Haute Saône, having travelled in company S. 51° E., 295 miles. On September 21 two others started together in a dead calm, made a perpendicular ascent of about 2000 feet, and disappeared in a cloud. Within 12 hours both dropped in the streets of Cassel, Germany, the course and distance being N. 85° E., 365 miles, at a rate of 30 miles an hour. Numerous balloons were sent off on September 9, under well-marked anticyclonic north wind conditions. The cards of 43 of them were recovered within a small area in the north of France, nearly all having followed a course between S. 2° E. and S. 5° E. They had attained an altitude where the wind was of gale force, one of the balloons, found 2½ hours after its despatch, having covered 108 miles, at a rate exceeding 43 miles an hour. Of a different character were the flights of September 13, the balloons being liberated in front of a cyclone approaching Brighton from the midland counties. The cards of 20 were returned, and of these 15 were drawn into the cyclone and descended in various places in Kent, Essex, Suffolk, Bucks, and Berks—the greater part of the circuit of the cyclone. The other five, apparently attaining a higher altitude, were caught in a westerly, veering north-westerly, current, which carried them to north-eastern France. One dropped at St. Ouen, Paris, 226 miles distant from another despatched at the same time, which descended at Thatcham Park, Stowe, Bucks.

Active Hydrogen and Chlorine.—In the Proceedings of the Science Association, Maharajah's College, Vizianagram, published in December 1922, Mr. Y. Venkataramaiah gives an account of some further experiments he has made on active hydrogen. Hydrogen gas obtained by the action of heat, and of water, on sodium hydride, as well as hydrogen gas which had bubbled through molten sodium, reacted with sulphur in the cold, and therefore contained active hydrogen. Similar results were obtained with potassium and calcium. Other methods for the activation of hydrogen (burning oxygen in hydrogen, surface combustion of hydrogen and oxygen on platinum, high tension arc in hydrogen, high temperature arc in hydrogen, and the passage of hydrogen through heated platinum and palladium) are described in further papers. In the same journal Mr. Venkataramaiah describes the activation of chlorine, prepared by heating gold chloride and dried with phosphorus pentoxide, by the silent discharge, by electric discharges in the gas, by ultra-violet light, and by the heat of an electric arc. The gas combines with ozone to form Cl_2O, with sulphur to form S_2Cl_2, and reacts with benzene in the dark to form $C_6H_6Cl_6$.

The Herbert Pendulum Hardness Tester.—Two points to be looked for in a "hardness" tester are simplicity of operation and results independent of the mass and thickness of the specimen. These are among the desirable features of a new instrument made by Messrs. Edward G. Herbert, Ltd., of Manchester, others being portability and the immunity of the specimen from damage due to testing. Thin strip, case-carburised steels, minerals, and glazes on pottery thus come within the scope of the machine. The apparatus consists of an arched casting weighing 4 kg., surmounted by a curved spirit-level graduated from 0 to 100. It is supported on the specimen by a 1 mm. ball fixed beneath the centre of the arch. With the standard setting the instrument has its centre of gravity 0·1 mm. below the centre of the ball, and is thus free to oscillate. "Scale tests" are made by placing this rocker normally on the specimen and tilting it until the level-bubble reads 0. On releasing the instrument the graduation to which the bubble floats is the "Scale Hardness Number" (*e.g.* glass 97, mild steel 30). The recommended "Time tests" are made by causing the "pendulum" to oscillate and noting with a stop-watch the time for ten swings. Strange to say, while mild steel requires 20 seconds, the "Time Hardness Number" of glass is 100 seconds. Both tests, then, depend upon the degree of indentation of the specimen, and a time factor appears to be involved. There is good agreement between successive determinations. While the instrument detects "strain-hardness," it does not appear to indicate relative machining properties. The high ranges of the time hardness scale may be opened out by raising the centre of gravity of the "pendulum," and altogether the system presents many important possibilities.

The "Zoological Record."

With the exception of the "Archiv für Naturgeschichte," which is about nine years behindhand and consequently of very little use, the "Zoological Record" is at present the only bibliographical guide to zoological literature being published in the whole world. In the annual report which the Council of the Zoological Society will lay before the forthcoming annual general meeting it is recommended that the Society shall not undertake the printing of any further volumes after the issue of the one in hand unless it receives substantial assistance towards meeting the cost. It is estimated that the cost of preparation and printing is 1900*l.*, towards which about 800*l.* is received from sales and subscriptions, leaving a net cost of 1100*l.*

With the object of ascertaining the views of other societies interested in scientific zoology on the question, a meeting of representatives was held in the Board Room of the Natural History Museum on April 16. In the absence of Sir Sidney Harmer, the director, owing to a family bereavement, the chair was taken by Lord Rothschild, a Trustee of the Museum and himself an eminent zoologist. Among the institutions and societies represented were the following: Linnean Society, Geological Society, Marine Biological Association of the United Kingdom, Imperial Bureau of Entomology, British Ornithologists' Union, British Ornithologists' Club, Royal Society of Tropical Medicine and Hygiene, Wellcome Bureau of Scientific Research, Malacological Society, Conchological Society, Challenger Society, Entomological Society of London. Letters urging the need for the "Zoological Record" were received from representatives of the Tropical Diseases Bureau, Liverpool School of Tropical Medicine, and the Universities of Cambridge, Durham, Birmingham, and Wales. The meeting was unanimously agreed as to the imperative need for the continuance of the Record, and authorised Sir Sidney Harmer to form a committee of those interested to confer with the Zoological Society as to the arrangements for carrying on the work.

In response to a question as to the attitude of the Trustees of the British Museum, Lord Rothschild stated that they had ordered the following statement to be sent to the Zoological Society for use in support of its appeal for assistance:

"The Trustees of the British Museum recognise the great value of the services rendered to science by the Zoological Society, which has for some years produced the annual volumes of the 'Zoological Record.' The indexing, year by year, of the names of newly-described genera and species, and of alterations in the names of others, may be regarded as an absolutely essential adjunct to work in this science. Although primarily of importance to systematists, the establishment of a correct nomenclature and the recording of new names are quite as necessary to workers in other branches of zoology, who are ultimately dependent on the systematists for the discrimination of the species with which they deal. With the accumulation of an enormous body of new facts, increasing in amount each year and much of it hidden away in the pages of publications which are difficult of access, the study of zoology is peculiarly dependent on having the record kept complete and up-to-date. The work of future naturalists would become almost impossible if each investigator had to make for himself a complete survey of the literature of his subject, published during many years without being indexed. The Trustees are accordingly of opinion that the continued publication of the 'Zoological Record' is indispensable to the progress of zoology. They have heard with regret that the Council of the Zoological Society is unable to undertake the sole financial responsibility for the appearance of the annual volume, and they have no hesitation in expressing their conviction that in these circumstances a strong effort should be made to obtain contributions from scientific societies and other bodies interested, with the view of relieving the Zoological Society of a part of the burden which it is no longer willing to carry unaided."

Agricultural Progress in India.

The steady advance in the progress of scientific agriculture in India is reflected in a recent number of the *Agricultural Journal for India* (xvii., part vi.), in which a variety of experimental work is reported. D. R. Sethi describes successful attempts to reclaim large tracts of the desert area of the Kapurthala State, illustrated by striking photographs. Since 1918 about 100 acres of the worst land in the district have been levelled and provided with an ample supply of irrigation water, free from alkali salts, by means of a large tube well equipped with power-driven machinery. The loose sandy soil was rendered more tenacious by green manuring with sann-hemp, which decays in about a fortnight after ploughing in and has a most marked action in binding the sand together, further improvement being effected by the introduction of clay carted from the low-lands. Good crops of maize, cotton, wheat, sugar-cane, cow-peas and other leguminous crops are now being grown on the land, and it is hoped to be able to render such reclamation an economic proposition.

As the relative value of nitrogenous organic manures depends largely upon their nitrifiability, F. J. Plymen and D. V. Bal have tested a number of these on various typical soils of the Central Provinces and Behar, under varying conditions of climate and cultivation. The nitrogen of castor cake appears to be quickly available in most soils, the others following in decreasing order of availability. Ground nut cake is exceptional in that it decomposes slowly in most soils, but very rapidly and effectively in black cotton soil. The nitrifying power of typical rice soil, where the cultivation is of an anaerobic or semi-anaerobic nature during a great part of the year, is much less than that of soils subject to open cultivation.

The phosphatic manuring of rice soil has received attention from M. R. Ramaswami Sivan in pot and field experiments with Trichinopoly phosphatic nodule. This mineral contains too much lime, iron, and alumina to be manufactured economically into superphosphate, but it appears to be a suitable manure for paddy lands when applied with decomposing organic matter. In pot cultures with rice the phosphate alone was ineffective, but the addition of green manure brought the phosphate into action and resulted in a very considerable increase in crop. Nitrogen, as sulphate of ammonia, was a less efficient agent in rendering the phosphate available. The residual effect of this mineral phosphate seems to be considerable, but this point is still under investigation.

The hydrogen-ion concentrations of some Indian soils and plant juices have been determined by W. R. G. Atkins (Bull. 136, Agricultural Research Institute, Pusa), who suggests that the method may be useful to agriculture in various ways, as, for example, to delimit the degrees of soil acidity or alkalinity within which it is possible to grow certain crops, and to determine the lime requirements of particular soils. The acidity of some sandy Assam soils is suggested as the cause of their high content of available phosphate, which is beneficial to indigo and other crops. The reaction even of highly calcareous soils may be somewhat modified by manurial treatment, the use of such manures as sulphate of ammonia or potash rendering the soils slightly less alkaline, the reduction being about P_H 0·4. A further reduction takes place in waterlogged soil, owing to the accumulation of carbonic acid. The value of gypsum on black alkali lands is attributed to the fact that calcium sulphate will, by precipitation of calcium carbonate, reduce the alkalinity of a sodium carbonate solution from P_H 10 or less to P_H 8, the latter being a limit suitable for plant life, whereas the former is not.

Fact and Phantasy in Industrial Science.[1]

The title of the lecture is intended to add to the obvious meaning of "industrial science" the complementary idea of a discipline or school of philosophy, and an interpretation under which the antithesis conveyed in the current expression "pure and applied science" is divested of any unreality. In regard to accumulation of exact knowledge of phenomena, no distinction of method or object is evident. "Pure science," however, is ideal in a sense which seldom characterises industrial research or scientific development of production.

The cellulose industries represent a vast accumulation of exact knowledge and a formidable array of statistical evaluation of fundamental matters of accepted fact. This tends to eliminate phantasy and imagination from the investigation of the primary routine processes of these industries, whereas these faculties have full play in the secondary arts of decorative treatment, *e.g.* in weaving design, bleaching and finishing, dyeing and printing: on the other hand, science has contributed new products, *e.g.* mercerised cottons, and the artificial (cellulose) silks, and attendant progressive extensions and developments, both artistic and scientific. Systematic scientific study of cotton, as an organic structure, as a colloidal complex with specifically characteristic hydration capacity, and as a chemical individual, is opening a vista of new developments of the primary textile industries.

Moreover, industrial research in this section adopts the unit cotton hair, as the determining factor of the industry, which is a radical change of the basis of accepted fact, from the empirical to the scientific. Similarly in the papermaking industry, current research concerns itself with units of minute dimensions, and the phenomena of the unseen and subsensible order. This trend of research again involves the faculties of phantasy and its more disciplined form of imagination.

The future of creative or constructive development of the cellulose industry would appear to be bound up with the application of physical and biological method: the former in investigating the properties of cellulose as such, and its actions and reactions in relation to light, heat and electricity; the latter in investigating the conditions of origin of cellulose structures, the natural history of bacterial resolutions, and the formation of humus, peat, lignite and coal. This general sketch of the matter of the lecture was developed by specimens and demonstrations.

[1] Abstract of a discourse delivered at the Royal Institution on Friday, February 2, by Mr. C. F. Cross, F.R.S.

Depth of Earthquake Foci.

The question of the depth of earthquake foci is attracting considerable attention among seismologists, and forms the subject of several recent papers (Mon. Not. R.A.S., Geoph. Sup., vol. i., 1923, pp. 15-22, 22-31, and 50-55). In the first of these Dr. Dorothy Wrinch and Dr. H. Jeffreys consider the seismic waves from the Oppau explosion of September 21, 1921, which were registered at five observatories on the Continent at distances ranging from 110 to 365 km. from Oppau. Using the method of least squares, they find that the velocities of the P and S waves (first and second preliminary tremors) are respectively 5·4 and 3·15 km. per sec. These values, which are of course those for the superficial sedimentary layer, are much less than those determined from observations of earthquake waves (7·1 and 4·0 km. per sec.) for the upper layers.

A more important earthquake with a superficial origin is the Pamir earthquake of February 18, 1911, which, as Prince Galitzin suggested and Dr. Jeffreys has shown, was the result of the fall of a great landslip. This earthquake was recorded at seismological stations all over the world. Dr. Jeffreys compares the times of arrival of the P and S waves at various distances from the origin with those given by the standard tables. The latter represent the average of a large number of earthquakes, the foci of which were situated at various, though unknown, depths, but none of which was on the surface. Now, if the latter depths were great, as suggested by the late Dr. G. W. Walker, there should be considerable differences between the observed times for the Pamir earthquake and those given by the tables. From the absence of any such differences, Dr. Jeffreys concludes that the foci of the earthquakes on which our tables are based were not at depths greater than 120 km.

In the third paper, Prof. Turner supplements a former note (see Nature, vol. 110, p. 55). Observations on the angle of emergence of earthquake waves at Pulkova led Galitzin to discern the existence of three new "critical surfaces" at the depths of 106, 232, and 492 km. Prof. Turner remarks that the relative depths of earthquake foci also concentrate about three chief values. The absolute depths are unknown, but, if they are the same as those of Galitzin's surfaces, they result in a surface value of the P waves agreeing with that obtained from the Oppau explosion, and suggest that destructive earthquakes probably originate in the uppermost layer, at a depth of 106 km.

Prof. Omori attacks the question from a different point of view, but also depends on time-observations (*Japanese Journ. of Astr. and Geoph.*, vol. 1, 1922, abstracts p. 16). He finds that the distance (x km.) of a station from the earthquake centre and the duration (y sec.) of the first preliminary tremor at the station are connected by the relation $x = 7{\cdot}42y$. From observations made at three stations (Tokyo, Mito, and Choshi), he finds that the focal depths of ten earthquakes felt at Tokyo in 1919–1921 range between 27·5 and 46·0 km., with an average of 34 km. In a later paper (*Seismol. Notes*, vol. 1, No. 3), he assigns, by the same method, a depth of 48 km. to the focus of the semi-destructive Tokyo earthquake of April 26, 1922. C. D.

University and Educational Intelligence.

Belfast.—At the meeting of Senate of the Queen's University held on April 20, it was agreed to receive the resignation of the vice-chancellor, the Right Honourable and Rev. Thomas Hamilton. Dr. Hamilton was appointed vice-chancellor by Queen Victoria in 1889 as president of Queen's College. At that time the annual endowment was 8000*l.* and the number of students less than 400. The annual endowment is now 36,000*l.* and the number of students 1250. During his long presidency his services were invaluable. In 1901 a fund of 100,000*l.* for the better equipment of the College was received, which made possible the erection of laboratories for teaching and research. By the Universities Act of 1908 the Queen's College was dissolved and became the Queen's University, and Dr. Hamilton was named in the charter as vice-chancellor and president. The Senate appointed a special committee to make inquiries as to a person suitable for nomination to the office of president and vice-chancellor.

Leeds.—The Leeds Education Committee and the University have co-operated in setting up a new course of training for students who may expect to occupy posts of directive responsibility in the printing trades. The University has no Printing Department of its own; but in other respects is able to offer the kind of training which is needed by a man who will afterwards take a responsible position in business life. The Leeds Technical School Printing Department, on the other hand, is to provide technical training in the various processes of printing and the full course will extend over four years. The first three years will be spent in reading for the University degree, one of the subjects for which will be printing. A fourth year, leading to a diploma, will be spent wholly on printing at the Technical School. The work for the degree will comprise economics, including commercial and financial organisation and the economics of the printing and allied industries, statistics, accountancy, commercial law, mathematics, physics, mechanical engineering, and printing. The scheme will come into operation next October.

The Dewsbury County Borough Council has voted a grant of 400*l.* a year to the University and the Halifax County Borough Council has made a grant of 750*l.* for the current financial year.

Dr. R. W. Whytlaw-Gray, Fellow of University College, London, has been appointed professor of chemistry as from October 1 in succession to Prof. Arthur Smithells. From 1900 to 1902 Dr. Whytlaw-Gray worked under Sir William Ramsay on a re-determination of the atomic weight of nitrogen. This work was completed in the laboratory of Prof. R. Anschütz in the University of Bonn. On his return from Germany in 1906 Dr. Whytlaw-Gray was appointed on Sir William Ramsay's staff at University College, London, and in 1908 he became assistant professor. While there, he conducted important investigations on the physical constants of gases and was associated with Sir William Ramsay in the well-known work on radium emanation (niton). This work involved exceptional experimental difficulties, less than one-tenth of a cubic millimetre of the gas being available. With this almost infinitesimal quantity Messrs. Ramsay and Whytlaw-Gray succeeded in determining its physical properties, thus proving that the emanation belonged to the helium family of elements. In connexion with this very delicate work, Dr. Whytlaw-Gray constructed a specially designed balance which was sensitive to 1/250 thousandth of a milligram. Since 1914 Dr. Whytlaw-Gray has been science master at Eton College.

London.—A course of eight free public lectures on "Nutrition" will be given at King's College for Women (Household and Social Science Department), 61 Campden Hill Road, W.8, by Prof. V. H. Mottram, on Mondays and Wednesdays, beginning on April 30. The lecture hour is 4.30, and no tickets are required.

Oxford.—The next award of the Rolleston Memorial Prize will be made in Trinity Term, 1924. The Prize, the value of which is about 100*l.*, is given for original research in animal and vegetable morphology; physiology and pathology; or anthropology. Candidates must be graduates of Oxford or Cambridge of not more than six years' standing. For other conditions the *Oxford University Gazette* for April 11 should be consulted. Candidates wishing to compete must forward their memoirs to the Registrar of the University of Oxford before March 31, 1924.

Mr. George Grant, Appointments Secretary and Senior Warden of the University Halls of Residence for Men Students, University of Liverpool, has been appointed Registrar of University College, Southampton, as from September 1, 1923.

Dr. S. P. Smith has been appointed professor of electrical engineering at the Royal Technical College, Glasgow, in succession to Prof. Magnus Maclean, who is about to retire after occupying the chair for twenty-four years. Since 1912, Dr. Smith has been lecturer, and later assistant professor, in the Electrical Department of the City Guilds (Engineering) College, Imperial College of Science and Technology, London.

An important conference is being organised by the University of Leeds for the discussion of certain questions affecting the supply of full-time education for boys and girls beyond the age of eleven years and the choice of subjects in school examinations. The conference will be held in the Great Hall of the University on Saturday afternoon, June 9, and will be attended by representatives of schools and universities, as well as by others engaged in educational work. The main subject of discussion will be the broadening of the basis of the secondary-school curriculum. Though less than three per cent. of pupils in State-aided secondary schools proceed to universities, the courses usually followed lead to examinations of university matriculation standard and scope, and are unsuitable for pupils who will not continue their education at universities. The following motions will therefore be put before the conference for consideration, and a vote will be taken upon them:—(1) That representations be made to the Board of Education, urging the pressing need of further provision (by legislative change, if necessary) for the full-time education of boys and girls up to the age of sixteen, to include not only instruction of the type now offered by the recognised secondary schools, but such variations from it as will meet the needs of pupils who may not intend to proceed to a university. (2) That this conference welcomes the recent action of the Joint Matriculation Board of the Northern Universities in the direction of allowing greater freedom in the choice of subjects in the First Secondary School examination, but is of opinion that greater freedom in the grouping of courses for the Higher Certificate is desirable in the educational interests of the pupils in secondary schools. Correspondence on the subject of this conference may be addressed to Sir Michael Sadler or to Mr. A. E. Wheeler, The University, Leeds, who will be glad to have the names of those intending to be present at the conference.

Societies and Academies.

London.

Geological Society, March 28.—Dr. H. H. Thomas, vice-president, in the chair.—E. **Greenly**: Further researches on the succession and metamorphism in the Mona complex. Fragments from the volcanic series of Bangor show that the metamorphism of the complex is older than that series. The basic schists of the Eastern Aethwy region appear to be derived from the spilitic lavas. A singular effect of anamorphism in its earliest stages is that quartz-epiclasts have been corroded and invaded by the carbonates of a calcareous grit. Titaniferous varieties of the Bodwrog marble in the Penmynydd Zone furnish evidence as to the conditions of development, under dynamic metamorphism, of rutile and of sphene. As regards the ancient floor, more fragments of ancient crystalline schists have been found, one of them being in the Fydlyn Beds, a lower horizon than any that had hitherto yielded any such fragments. The gneissic structures are older than the deposition of the bedded succession. Banding resulted from deformation of a differentiated basic magma at an advanced stage of consolidation. Three generations of pegmatite are distinguished, the earliest of which is subsequent to the consolidation of the banded gneiss. Granitoid banding followed granitoid permeation, and also the appearance of the basic magma from which the hornblendic gneisses were developed. Thus, the micaceous gneisses must be regarded as the oldest known member of the gneissoid complex.

Aristotelian Society, April 9.—Prof. A. N. Whitehead, president, in the chair.—C. D. **Broad**: Various meanings of the term "unconscious." Six senses of the term "unconscious" are distinguished. (1) As used to differentiate one kind of substance from another, it means "inanimate." (2) As applied to the temporary condition of an animate substance, it means "not at the moment consciously aware of anything." This definition is not complete till we have defined (3), "conscious" and "unconscious," as applied to experiences. An experience is "relatively unconscious" if it is owned by some mind which is not at the time in control of a body. It is "absolutely unconscious" if, at the time of its occurrence, it is owned by no mind. These are the only senses in which we can *literally* talk of "unconscious *experiences*." (4) The traces and dispositions which have to be assumed in order to explain memory, instinctive behaviour, etc., are often called "unconscious states." There is no reason to think that these are, or are anything like, experiences. It is best to call them "mnemic continuants." (5) Experiences which were conscious when they happened, but cannot now be remembered by normal means, are often called "unconscious." It would be better to call them "inaccessible." Their traces form part of the unconscious in sense (4). They themselves are not literally unconscious experiences in sense (3). Lastly, (6) the name "unconscious" is often applied to ordinary conscious experiences (especially desires and emotions) which are not properly discriminated by their owner because the acknowledgment of their true nature and objects would be unflattering to him.

Royal Meteorological Society, April 18.—Dr. C. Chree, president, in the chair. W. H. **Dines** and L. H. G. **Dines**: An examination of British upper air data in the light of the Norwegian theory of the structure of the cyclone. A list of dates on which temperature observations were available in England S.E. was sent to the Meteorological Office, which notified all those on which evidence of the polar front might be expected. Graphs of the lapse rate from 0·5 km. to 5·0 km. were drawn for such dates, but no peculiarities not readily explained by the ordinary casual variation were found. The probability of finding an inversion appears to be almost a linear function of the surface pressure. Kite ascents made at Pyrton Hill indicate that an inversion is nearly always associated with a decrease in the humidity, whereas the Norwegian theory requires an increase. The observational evidence for England does not support the theory that the superposition of equatorial over polar air is the usual form of the structure of a cyclone.—T. **Kobayasi**: On the mechanism of cyclones and anticyclones. Mathematical expressions are obtained which represent a cyclone having definite properties. As the cyclone advances it draws into its inner region a strip of air lying near the ground in its track. Meanwhile the air outside the two edges of the strip flows round the opposite sides of the cyclone, meeting behind it. Thus if the portions of air outside the two edges of the strip were at different temperatures, then by their contact they would produce the instability which is characteristic of the squall line.—E. C. **Shankland**: Notes on the fluctuations of mean sea-level in relation to change of atmospheric pressure. The heights to which tides will rise in the world's principal harbours and estuaries are pre-determined by analysis and presented to navigation in the form of tidal predictions. Meteorological conditions interfere with these predictions. Observations show that the mean sea-level varies inversely with the height of barometer; there is a tendency to increase the factor from 13·25 (the specific gravity of mercury as compared with sea-water), to a figure approaching 20 when using the mean isobar of the locality as barometric datum. Observations extending over a period of autumnal anti-cyclonic weather of considerable geographic extent, point to the acceptance of a 1/20 factor under these meteorological conditions, the barometric pressure being above normal during the entire series.

Paris.

Academy of Sciences, April 3.—M. Guillaume Bigourdan in the chair.—Emile **Picard**: Two elementary theorems on the singularities of harmonic functions.—M. **de Sparre**: The yield of reaction turbines furnished with aspiration tubes. Modifications of the formulæ given in earlier communications produced by the addition of an aspiration tube, with and without partitions. An example is given in which the initial maximum yield was 0·816, with simple aspiration tube 0·865, and a still higher figure for certain cases of tubes with partitions.—E. **Mathias**, C. A. **Crommelin**, and H. Kamerlingh **Onnes**: The latent heat of vaporisation and the difference of the specific heats in the saturated state for neon. A table is given showing the molecular heats of vaporisation for oxygen, argon, nitrogen, neon, and hydrogen.—S. **Lefschetz**: The integrals of the second species of algebraical varieties.—G. **Valiron**: Remarks on a theorem of M. Carlemann.—Hilaire **de Barenton**: A new interpretation of the Sothaic period. A new theory of the ancient Egyptian calendar. L. **Vegard**: The spectrum of the aurora borealis and the upper layers of the atmosphere. An account of work done at the Tromsö Geophysical Institute. The greater number of the lines in the spectrum of the aurora borealis can be identified with nitrogen lines, but there are four lines not given for nitrogen, which cannot be attributed to hydrogen, oxygen, or helium. There is no evidence for the existence of hydrogen or helium in the upper atmosphere. It is possible that the four lines not identified, including the green line (5578·4), may be due to nitrogen.—L. **d'Azambuja**: New measurements of the velocity of rotation of the filaments. Evaluation of the height of these objects above the solar chromosphere. The average velocity does not sensibly vary from one filament to another: it is independent of the shape, intensity, and extent of the filaments observed. There is a clear reduction of velocity toward the pole, the angular velocity being $14 \cdot 45° - 1 \cdot 90° \sin^2 \lambda$, where λ is the heliographic latitude.—Louis **Dunoyer**: Induction spectra and spark spectra. Reclamation of priority as regards work by Léon and Eugène Bloch, and a discussion of the nomenclature of spectra.—Pierre **Lamare**: Geological observations on the Yemen. The region of the Yemen (south-west angle of Arabia) presents remarkable geological and lithological analogies with the Somali and Abyssinian regions. The properties of the six main types of basalts are summarised.—C. E. **Brazier**: Magnetic measurements in Normandy. The magnetic elements (on January 1, 1922) are given for 43 stations in the Departments of Eure and Seine-Inferieure.—Mlle. Y. **Dammann**: The Kansou earthquake: determination of the epicentre. This earthquake took place on December 16, 1920, in the north China province of Kansou, and for the determination of the epicentre the seismological records from 24 observatories were utilised.—Mme. J. Samuel **Lattès**: Some numerical values characterising the radium rays responsible for the phenomenon of necrosis.

Official Publications Received.

Papers and Proceedings of the Royal Society of Tasmania for the Year 1922. Pp. v+104+8 plates. (Hobart: Tasmanian Museum.) 10s.

Reports of the Council and Auditors of the Zoological Society of London for the Year 1922, prepared for the Annual General Meeting to be held on Monday, April 30, 1923. Pp. 55. (London.)

Review of Agricultural Operations in India, 1921–22. Pp. vi+160. (Calcutta: Government Printing Office.) 1.4 rupees.

The Science Reports of the Tohoku Imperial University, Sendai, Japan. Second Series (Geology). Vol. 6, No. 2: On some Tertiary Brachiopods from Japan. By Ichirō Hayasaka. Pp. 25+2 plates. (Tokyo and Sendai: Maruzen Co. Ltd.)

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1922. Pp. ii+14. (Cape Town.)

Report and Balance Sheet of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape (and the Karroo Garden, Whitehill, near Matjesfontein), for the Year ending 31st December 1922. Pp. 23. (Kirstenbosch.)

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. New Series, No. 15, April. Edited by W. F. Spear. Pp. 196. (London.)

Diary of Societies.

SATURDAY, April 28.

Royal Institution of Great Britain, at 3.—Dr. L. L. B. Williams: The Physical and Physiological Foundations of Character (1).

MONDAY, April 30.

Institute of Actuaries, at 5.—A. D. Besant: Notes on some Actuarial Aspects of the Local Government and other Officers' Superannuation Act, 1922, and on a Method suitable for the Initial Valuation of a Small Fund of the "Officer" Type.

Royal College of Surgeons of England, at 5.—Prof. Shattock: Spina Bifida, etc.

Royal Society of Arts, at 8.—S. S. Cook: Recent Improvements of the Steam Turbine (1). (Howard Lecture.)

TUESDAY, May 1.

Royal Institution of Great Britain, at 3.—Sir Arthur Keith: The Machinery of Human Evolution (4). Are our Bodies Changing?

Royal Institution of Great Britain, at 5.—Annual Meeting.

Royal College of Physicians of London, at 5.—Dr. H. H. Dale: The Activity of the Capillary Blood-vessels, and its Relation to Certain Forms of Toxæmia (Oliver-Sharpey Lectures) (1).

Royal Society of Medicine (Orthopædics Section), at 5.30.—Annual General Meeting.

Royal Photographic Society of Great Britain, at 7.—F. G. Tutton: Three-colour Carbro.

Royal Anthropological Institute, at 8.15.—V. G. Childe: The Neolithic Painted Pottery of South-Eastern Europe.

Röntgen Society (at Institution of Electrical Engineers), at 8.15.—C. Thurstan Holland: X-rays and Diagnosis (Sixth Silvanus Thompson Memorial Lecture).

WEDNESDAY, May 2.

Geological Society of London, at 5.30.—Prof. J. Joly: The Bearing of Some Recent Advances in Physical Science upon Geology.

Institution of Electrical Engineers (Wireless Section), at 6.—Prof. C. L. Fortescue: The Design of Inductances for High-Frequency Circuits.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.—W. Dickson: The Quantitative Determination of Hemp and Wood in Papers containing these two Fibres.—H. Jephcott: The Estimation of Fat, Lactose, and Moisture in Dried Milks.—A. L. Bacharach: The Estimation of Lactose by the Polarimetric and Gravimetric Methods.—M. S. Salamon: The Melting Point and Iodine Value of Refined Natural D. Camphor.—A. G. Francis: The Presence of Barium and Strontium in Natural Brines.

Royal Society of Arts, at 8.—M. Drake: The Fourteenth-century Revolution in Glass Painting.

Entomological Society of London, at 8.

Institute of Metals (at Institution of Mechanical Engineers), at 8.—Dr. W. Rosenhain: The Inner Structure of Alloys (Thirteenth Annual May Lecture).

THURSDAY, May 3.

Royal Institution of Great Britain, at 3.—Prof. J. T. MacGregor Morris: Modern Electric Lamps (2). Glowing Solids in Gases.

Royal Society, at 4.30.—F. A. E. Crew: Studies in Intersexuality. I.: A Peculiar Type of Developmental Intersexuality in the Male of the Domesticated Mammals.—E. J. Morgan and J. H. Quastel: The Reduction of Methylene Blue by Iron Compounds.—C. F. Cooper: The Skull and Dentition of *Paraceratherium bugtiense*. A genus of aberrant Rhinoceroses from the Lower Miocene Deposits of Dera Bugti.—Dr. W. L. Balls: The Determiners of Cellulose Structure as seen in the Cell Walls of Cotton Hairs.—I. de B. Daly: The Influence of Mechanical Conditions of the Circulation on the Electrocardiogram.

Linnean Society of London, at 5.—Dr. W. T. Gordon: The genus *Pitys*.—R. Gurney: The Crustacean Plankton of the English Lake District.—S. L. Ghose: A Systematic and Ecological Account of Blue-green Algæ from Lahore.—J. Groves: Notes on Indian Charophytes.—J. G. H. Frew: The Morphology of the Head and Mouth-parts of *Chlorops tæniopus* Meig. (Diptera).—A. M. Alston: The Genital System of the Beetle *Lyctus brunneus* Steph.

Royal College of Physicians of London, at 5.—Dr. H. H. Dale: The Activity of the Capillary Blood-vessels, and its Relation to Certain Forms of Toxæmia (Oliver-Sharpey Lectures) (2).

Chemical Society, at 8.—Prof. H. B. Baker: Change of Properties of Substances on Drying. Part II.—H. Bassett and P. Halton: The Sodium Salts of Phenolphthalein.—H. Bassett and R. G. Durrant: The Action of Thiosulphates on Cupric Salts.—R. G. W. Norrish and Dr. E. K. Rideal: The Conditions of Reaction of Hydrogen with Sulphur. Part II. The Catalytic Effect of Oxygen. Part III. On the Mechanism of the Reaction of Hydrogen with Sulphur and its Catalysis by Oxygen.—Prof. T. M. Lowry: Studies on Electrovalency. Part II. Co-ordinated Hydrogen.—H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XX. The Rational Study of Optical Properties: Refraction a Constitutive Property.

Royal Society of Medicine (Obstetrics and Gynæcology Section) (Annual General Meeting), at 8.—L. P. Pugh: Investigation into Ovarian Disease in Cows.—Dr. A. Donald: The Clinical Aspects of Adenomyomata of the Female Pelvic Organs.

FRIDAY, May 4.

Royal Astronomical Society (Geophysical Discussion), at 5.—The Volatilisation of Meteors, in relation to the Density and Temperature of the Air at 60 km. Chairman, Prof. A. S. Eddington. Opener, Prof. F. A. Lindemann; other speakers, Major G. M. Dobson, Sir Napier Shaw, and F. J. Whipple.

Institution of Civil Engineers, at 6.—Sir Richard T. Glazebrook: The Interdependence of Abstract Science and Engineering (Twenty-ninth James Forrest Lecture).

Junior Institution of Engineers, at 7.30.—S. A. Stigant: A.C. Neutral Point Earthing.

Royal Institution of Great Britain, at 9.—Prof. F. Soddy: The Origins of the Conception of Isotopes.

SATURDAY, May 5.

Royal Institution of Great Britain, at 3.—Dr. L. L. B. Williams: The Physical and Physiological Foundations of Character (2).

PUBLIC LECTURES.

MONDAY, April 30.

King's College for Women (Household and Social Science Department), at 4.30.—Prof. V. H. Mottram: Nutrition. (Succeeding Lectures on May 2, 7, 9, 14, 16, 23, and 28.)

TUESDAY, May 1.

King's College, at 5.30.—Prof. A. P. Newton: Africa and Historical Research.

THURSDAY, May 3.

St. Mary's Hospital (Institute of Pathology and Research), at 4.30.—Prof. W. Bulloch: Spallanzani's Researches on Respiration.

FRIDAY, May 4.

University College, at 5.—W. Macnab: Some Scientific Principles of Chemical Industry. (Succeeding Lectures on May 11 and 18.)

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground
Of Nature trusts the mind which builds for aye.*"—WORDSWORTH.

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Broadcasting and Wireless Licences.

THE wireless licence problem has for some time been engaging the attention of the Post Office authorities, and acute differences appear now to have arisen between the Postmaster-General and the British Broadcasting Company as to the conditions under which licences may be issued to amateurs who either own home-made wireless sets or desire to build up such sets. Matters have been brought to a head by the present Postmaster-General refusing to impose upon amateurs restrictions which the British Broadcasting Company claims it has a right, under its agreement with the Post Office, to insist upon. The Postmaster-General made a statement in the House of Commons on April 19 on the situation that has, in consequence, come to pass: he then informed the House that negotiations had taken place on the licence question between himself and the Company, and that the latter had suggested that the Post Office issue to the home-constructor a licence, without any clog, at 20*s.*, of which 15*s.* was to go to the Company. This proposal was promptly declined by the Postmaster-General. Then, in the course of further negotiations, the Company expressed its willingness to permit the Post Office to issue to amateurs a licence at 10*s.*, of which one-half was to go to the Company, but such licence was to be subject to the clogging provision that it should alone be issued to those home-constructors who either own, or propose to build up, listening-in sets with parts of "B.B.C." manufacture. This proposal has also proved unacceptable to the Postmaster-General.

It was perhaps inevitable, in view of the terms and conditions contained in the agreement entered into between the Post Office and the British Broadcasting Company, and of the provisions in the articles of association of the Company, that the present trouble should have arisen. Neither the Post Office authorities nor those responsible for the promotion of the British Broadcasting Company appear to have appreciated correctly certain psychological aspects of the wireless situation from the point of view of a large and important section of those interested in that field. The subject, it may be remembered, was well ventilated at the time that the provisional committee representing the promoters of the British Broadcasting Company was carrying on its preliminary negotiations in the autumn of last year. It should, therefore, have been clear to the Postmaster-General of the day, his advisers, and the promoters of the Company, that many conflicting interests were involved and that the greatest caution was needed in handling what was undoubtedly a difficult problem (see NATURE for August 19 and

October 7, 1922—vol. 110 at p. 237 and p. 469). The situation actually created by the agreement between the Post Office and the British Broadcasting Company has been such that, almost from the very beginning, two important classes—the small manufacturer and salesman of wireless apparatus and the amateur experimenter—in the wireless field have felt themselves seriously aggrieved by the policy adopted by the parties to the agreement in relation to wireless licences, owing to the deliberate attempt made to fetter their freedom of action, each in his own particular field.

As regards the small manufacturer, it is argued that he has no real cause of complaint, since by subscribing but for a single one-pound share he can at once avail himself of all the benefits secured by the British Broadcasting Company from the Post Office under its concession. However, there is a not unnatural objection and disinclination on the part of small manufacturers to join a combine in which their most powerful competitors have a preponderating influence and voice. Further, an impression prevails, rightly or wrongly, that the inquisitorial powers which the British Broadcasting Company appears to have acquired under its articles of association may be, and are being, used to the detriment of the smaller shareholding companies: for example, a suspicion exists that the organisation of the Company is being made use of by the powerful shareholding companies, to some extent, as a sort of intelligence department for the purpose of obtaining information likely to be useful in connexion with the protection of their patent rights and interests. In all the circumstances, then, it would obviously be wrong for the Post Office to take any action with the view of compelling any British manufacturer to join the Broadcasting Company: in this view the present Postmaster-General has expressed his concurrence.

One of the chief arguments used in favour of broadcasting services being provided alone by a single company, and of the present rule that only apparatus bearing the "B.B.C." mark shall be used for broadcasting purposes, is that the British market is being flooded with wireless apparatus manufactured in countries with depreciated currencies; and, therefore, without safeguards of the nature indicated here, the broadcasting industry would be destroyed. It may, of course, be of vital importance, as the British Broadcasting Company alleges to be the case, to protect from unfair foreign competition, at the present time, the industry in question. Should any protective measures be desirable, the proper method of dealing with this aspect of the situation is surely by the direct and open one of imposing on foreign telephone apparatus and parts an import duty to be collected in the ordinary way by the Customs authorities, and not by the indirect, clumsy, and, what must prove to be, ineffective method of attempting to prevent the use for a specific purpose, by means of ministerial regulations and articles of association of a trading company, of some particular material after its unrestricted importation.

As regards the other class the rights of which appear to be seriously infringed under the broadcasting agreement, that is to say, the amateurs, a misapprehension seems to exist in the minds of some of the promoters of the British Broadcasting Company as to the nature of the bargain made by them with the Post Office. Owing to the great and rapid increase in the so-called "experimental licences" issued since the advent of broadcasting—the actual increase is from about 10,000 in the summer of last year to 35,380 at the present date—the Company seems to have taken alarm at the construction placed by the Postmaster-General on the language of Section 2 (1) of the Wireless Telegraphy Act, 1904 (4 Edw. 7. c. 24), which authorises the issue on special terms of a licence to an applicant who "proves to the satisfaction of the Postmaster-General that the sole object of obtaining the licence is to enable him to conduct experiments in wireless telegraphy." Certain of the promoters of the Company appear to think that, in view of the terms and conditions of the agreement negotiated by them with the Post Office, they are to be the judges as to the meaning to be placed on the provisions of the Section of the Act referred to. They are inclined to put an exceedingly narrow construction on the language of the statute, and seem to claim that the issue of the "experimental licence"—the rights of the Postmaster-General in relation to the granting of which are in no way abrogated or restricted under the Company's broadcasting agreement—shall alone be to actual research students and those in a strictly analogous position: that is to say, they wish to see the ordinary amateur deprived of his right to an "experimental licence." Owing to the attitude taken up by the British Broadcasting Company, the issue of licences other than those in respect of the listening-in sets bearing the "B.B.C." mark has been suspended since January 1 last, and, in consequence, some 33,000 applications for "experimental licences" were waiting to be dealt with on April 19.

When addressing the House of Commons on April 19, the Postmaster-General announced that, in the opinion of the Law Officers of the Crown, if he is satisfied that the object of an applicant for a licence is to experiment in wireless telegraphy, not only may he issue an "experimental licence" to him, but also he is bound to do so. Accordingly, he has referred the outstanding applications in question to some expert members of his staff in order that they may advise him as to the cases in which the licences are being honestly sought for the purpose of conducting experiments in wireless telegraphy, and on this advice he intends forthwith to act. It would, indeed, be exceedingly mischievous if the narrow construction sought to be placed on the language of the statute as it affects "experimental licences" were to be accepted by the Postmaster-General. It is to be hoped that his expert advisers will deal with the question submitted to them in the light of the plain language of the Act of 1904 and in accordance with the well-known principles relating to the interpretation of the provisions of statutes which affect private rights. The expert advisers will, no doubt, bear in mind that in the case of any particular amateur the dominant reason prompting him to apply for a licence may well be, and often is, that he desires to conduct experiments, and, therefore, in his case as in that of the research student, the listening-in to broadcasting services is altogether a secondary consideration, although the existence of such services is possibly of some assistance to him in connexion with his experiments, and for this use he will, under the Postmaster-General's proposal, be contributing his 5*s.* a year.

The Postmaster-General made the further important announcement on April 19 that he proposed immediately to set up a committee consisting of members of Parliament, expert members of his staff, a member of the British Radio Society, and a director or other official of the British Broadcasting Company, if possible, to consider the whole future of broadcasting. The members of this committee have now been appointed and their names appear in another part of this issue. It is eminently desirable that a thorough inquiry should take place; in this way the various issues which have been raised can most satisfactorily be separated out, in order that each may be dealt with on a practical basis on its own merits. One of the most important of the questions upon which a sound decision is required is that relating to the position of the amateur worker in the wireless field: there are to-day thousands of young fellows who are induced to take up as a hobby some technical or scientific subject, owing almost entirely to the pleasure they derive in carrying out practical work with a view of obtaining a clear understanding of some of the mysteries of Nature. It is desirable that the committee which the Postmaster-General has now appointed should make a definite pronouncement on this particular point: it cannot fail fully to recognise the importance of seeing that nothing is done unreasonably to hamper the activities of this particular class of workers in the wireless field; indeed, it is likely to appreciate the value of encouraging them, both with the view of benefiting science by their work and by their inventive faculty, should they possess any, as well as of assisting the industries of the country by the trade in the sale of the materials they may require for the purposes of their experiments.

History teaches that there are certain directions in which an attempt to impose statutory restrictions prompts people alone to measures of evasion, and on so wholesale a scale as practically to paralyse the arm of the law: to mention but a single example, the legislature, with doubtful wisdom, endeavoured at the beginning of the eighteenth century to suppress the so-called "Common-law Companies," and passed the famous Bubble Act, 1718 (6 Geo. I. c. 18), with this object in view. The Act, as is well known, proved a dead letter and was, a century later, repealed; the legislature, finding that it must tolerate the joint-stock company, set accordingly to work to regulate what it could not suppress, and to-day the whole country is reaping benefit from the facilities which were created to permit the incorporation of commercial and industrial undertakings. The present situation in relation to the amateur worker in the wireless field is almost identical with that which existed a couple of centuries ago in relation to the joint-stock company. It behoves those, then, who may be called upon to deal with the wireless licence problem to bear steadily in mind the teachings of history of the kind to which this allusion refers.

Biology in Utopia.

Men Like Gods. By H. G. Wells. Pp. viii + 304. (London, New York, Toronto and Melbourne: Cassell and Co., Ltd., 1923.) 7*s.* 6*d.* net.

THE columns of NATURE are not the place to discuss the literary merits of Mr. Wells's new book—although, for the matter of that, good style or artistic capacity and appreciation are qualities as natural as any others. Suffice it to say that he has achieved a Utopian tale which is not only interesting but also extremely readable. Most readable Utopias are in reality satires, such as "Gulliver's Travels," and the no less immortal "Erewhon." Mr. Wells has attempted the genuine or idealistic Utopia, after the example of Plato, Sir Thomas More, and William Morris; and, by the ingenious idea of introducing not a solitary visitor from the present, but a whole party of visitors (including some entertaining and not-at-all-disguised portraits of various living personages) has provided a good story to vivify his reflections.

However, since Mr. Wells is giving us not only a story, but his idea of what a properly-used human faculty might make of humanity in the space of a hundred generations, his romance has become a fit subject for biological dissection in these pages.

Mr. Wells pictures a world where, in the first place, the advance of physico-chemical science and its application, to which we are already accustomed, has attained a far higher pitch of perfection. Further, machinery has become so self-regulating that it does not make man captive, as Samuel Butler prophesied, but is a real servant. Also, instead of machinery and mechanism occupying the foremost place in the life of the majority of men, as Bergson laments that they are tending to do to-day, they have apparently been rendered not only more efficient, but also more self-regulating, and are as subservient to the will of the community as a motor-car that never gets out of order is to its owner.

In the second place, life has been subjected to a similar control. This is a process which the biologist sees so obviously on its way that it should excite no surprise. As our knowledge of genetics increases, our application of it must outstrip the past achievements of empirical breeding as much as the application of scientific knowledge of principle in chemistry, say, or electricity, has outstripped the achievements of empiricism in those fields. Mr. Wells's wonderful flowers and trees are almost there already: we will not worry about them. Even his domestic-minded leopards and tigers, more "kittenish and mild" even than Mr. Belloc's, should not be lightly dismissed after recent experiments on the inheritance of tameness and wildness in rats—not to mention our knowledge of many breeds of dog.

Meanwhile, Mr. Wells also imagines a purging of the organic world. The triumphs of parasitology and the rise of ecology have set him thinking; and he believes that, given real knowledge of the life-histories and inter-relations of organisms, man could proceed successfully to wholesale elimination of a multitude of noxious bacteria, parasitic worms, insects, and carnivores. Here again we have no right to quarrel. Mr. Wells does not need to be reminded of the thistle in California or the rabbits in Australia: his Utopians proceed with exemplary precautions. All this is but an extension of what has already been begun.

In the third place, however, human as well as non-human life has been subjected to this control; and this in two ways. First, by an extension of the methods previously used. The accidents and circumstances of life have been altered—there has been a further control of external machinery. This has been, of course, chiefly in the fields of social and political institutions. A great part of such change is only intelligible as a corollary of the other supposed change. But we may here direct attention to one idea which is imagined as at the root of much of it—the idea that man is master in his own house of Earth, as opposed to the idea which, with few exceptions, has until now dominated his history—the idea that he is the slave, sport, or servant of an arbitrary personal Power or Powers.

Finally, we come to the most radical and inevitably the most provocative of our author's imaginings—that which concerns not the alteration of things in relation to a constant human nature, but the alteration of that human nature itself. Here Mr. Wells is extremely interesting. He reduces the rôle of eugenics to a minimum, exalts that of education, or, if you prefer it, environment, to a maximum. Eugenic change has been restricted to "breeding out" (Mr. Wells does not initiate us into methods) certain temperamental qualities—habitual gloominess, petty inefficiency, excess of that "sacrificial pity" Mr. Wells dislikes so much, and so forth.

The rest has been accomplished by proper education, and, above all, by a "change of heart" as regards the essential aims of life. Mr. Wells sums this up in a phrase (in which one recognises his devotion to the late headmaster of Oundle) as the substitution of the ideal of creative service for that of competition.

The realisation of this ideal is made possible in the first instance by a proper application of psychology to early life, so that painful repression and stupid suppression shall not occur, and men and women shall grow up unridden by hags of sex or fear, and yet without separation of any important fragment of their mental organism from the rest. Education *sensu restricto* then steps in, and enlarges the capacities of the unhampered growing mind, while the substitution of a form of telepathy for speech reduces the time and energy needed for communication. Meanwhile, a rational birth-control provides a world not overcrowded and overstrained.

By these means, Mr. Wells imagines, a race has been produced of great beauty and physical strength, great intellectual and artistic capacities, interested primarily in two things—the understanding of Nature for its own sake, and its control for the sake of humanity. By control Mr. Wells means not only utilitarian control, but that which, as in a garden, is to please and delight, and that highest control of material—artistic and scientific creation.

The Utopians, owing to their upbringing and social environment, come to think and act so that they need no central government, no law-courts, no police, no contracts. In this Mr. Wells is only telling us what we all knew already, that in most men it seems theoretically possible to produce a "change of heart"—*i.e.* substitute new dominant ideas for old—and that if this is effected, restrictive measures gradually become unnecessary. He is careful not to make his Utopia too ideal. It is as ideal compared with this world as would be Olympus: but as short of perfection as Olympus seems to have been. The men and women there are often discontented and restless; criticism is abundant. Mr. Wells knows that intellectual and æsthetic achievement opens the door to the highest known happiness of the present; he keeps them so, with all conditions and limitations of their being, in Utopia.

Let us go back and try to see how much of Mr. Wells's speculations fall within the bounds of possibility. All Utopias must suffer from lack of familiar associations, for it is by familiar associations, especially with things of youth and childhood, that emotional appeal is made and real assent gained. Thus, whatever stores of loved memories a Utopian may have, whatever driving force he may draw from the sight of familiar places and objects, we can only see his emotional life from outside, as an Englishman on his first visit to the United States notices the differences from England rather than the resemblances. But if we remember that they must have each their private growth of life, and that this must be in many ways like ours, we get over the first stile.

We have already dealt with Mr. Wells's applied physics and chemistry and his applied biology of lower organisms. That in a sense is commonplace—commonplace made surprising; none the less, it is good to have it so well done, to have people reminded that the rate of this sort of change not only need not slow down, but can continue, and continue to be accelerated, for a very long time. What of his applied biology of man? Minor criticisms are easy to make. The Utopians, for example, go either almost naked, or else clothed in garb of the indeterminate simplicity that seems to be fashionable in all Utopias. Mr. Wells is perhaps so revolted by the dulness of modern male attire that he underestimates the amount by which dress enlarges the human horizon, giving us a hundred extra variations of personality, raising the possibilities realised in the courtship-decorations of lower animals to an infinitude of permutations.

With the rediscovery of Mendel's laws and their recent working out, we are introduced to the theoretical possibility of an analysis of the hereditary constitution similar to the chemist's analysis of a compound; and so, presumably, in the long run to its control. There are great technical difficulties in higher organisms, and application to man presents yet further difficulties. Still, the fact remains that the theoretical possibility exists for us to-day, and did not exist twenty-five years ago. We must further remember that all discoveries concerning the history of man remind us that we must think, not in centuries as heretofore, but in ten-thousand-year periods when envisaging stages in human development.

We must further recall the lessons of evolutionary biology. These teach us that, however ignorant we may be regarding the details of the process, life is essentially plastic and has in the past been moulded into an extraordinary variety of forms. Further, that the attributes of living things have almost all been developed in relation to the environment—even their mental attributes. There is a causal relation between the absence of X-rays in the normal environment and the absence in organisms of sense-organs capable of detecting X-rays, between the habits of lions and their fierceness, of doves and their timidity. There is, thirdly, no reason whatever to suppose that the mind of man represents the highest development possible to mind, any more than there was to suppose it of the mind of monkeys when they were the highest organisms. We must squarely recognise that, in spite of proverbs to the contrary, it is probable that "human nature" could be considerably changed and improved.

Next, we have the recent rise of psychology. Much nonsense doubtless masquerades under the name of psycho-analysis or "modern" psychology. None the less, as so shrewd a critic as the late W. H. R. Rivers at once saw, and as has been put to such practical uses in therapeutic treatment, there is not only something in it, but a great deal. Repression, suppression, sublimation, and the rest are realities; and we are finding out how our minds do work, ought not to work, and might be made to work. It is clear that the average mind is as distorted and stunted as a much-below-average body; and that, by just so much as a great mind is more different from an average one than great from average bodily capacity, by so much would proper training be more efficient with mind than even with bodies. Here the extravagances of some eugenists find their corrective; Mr. Wells's imagination is pursuing to its logical end the line taken by such authorities as Mr. Carr Saunders in his "Population Problem."

Again, Mr. Wells, being a major prophet, perceives without difficulty that the substitution of some new dominant idea for the current ideas of commercialism, nationalism, and sectarianism (better not beg the question by saying *industry, patriotism,* and *religion*) is the most needed change of all. Here, again, he is in reality only adopting the method of Lyell and Darwin—uniformitarianism—and seeking the key of the future, as of the past, in the present. There is to-day a slowly growing minority of people who not only profoundly disbelieve in the current conceptions *and valuations* of the world and human life, but also, however gropingly, are trying to put scientifically-grounded ideas in their place.

Belief is the parent of action; and so long as the majority of men refuse to believe that they need not remain the slave of the transcendental, whether in the shape of an imaginary Being, of the Absolute, or Transcendental Morality, they cannot reap the fruits of reason. If the minority became the majority, society and all its institutions and codes would be radically altered.

Take but one example, and a current one—birth-control. When Mr. Wells's "Father Amerton" finds that it is the basis of Utopian civilisation he exclaims in horror: "Refusing to create souls! The *wickedness* of it! Oh, my God!"

. . . . . .

This is the great enemy of true progress—this belief that things have been already settled for us, and the consequent result of considering proposals not on their merits, but in reference to a system of principles which is for the most part a survival from primitive civilisations.

Mr. Wells may often be disagreed with in detail: he is at least right in his premises. A perusal of his novel in conjunction with a commentary would be useful. "Men Like Gods" taken *en sandviche* with, say, Punnett's "Mendelism," Trotter's "Instincts of the Herd," Thouless's "Psychology of Religion," Carr-Saunders's "Population Problem," Whetham on eugenics, and a good compendium of recent psychology, would be a very wholesome employment of the scientific imagination. J. S. H.

Linnean Correspondence.

Bref och Skrifvelser af och till Carl von Linné med understöd af Svenska Staten utgifna af Uppsala Universitet. Första Afdelningen, Del 8: Bref till och från Svenska enskilda personer Kalm-Laxman. Utgifna och med upplysande noter försedda af J. M. Hulth. Pp. v+200. 6 kroner. Andra Afdelningen, Utländska brefväxlingen; Del 1: Adanson-Brünnich. Utgifven och med upplysande noter försedd af J. M. Hulth. Pp. viii+430. 12 kroner. (Uppsala: A.-B. Akademiska Bokhandeln, 1916 and 1922.)

SINCE the death of Carl von Linné, better known in this country under his Latinised name of Linnæus, nearly a score of works have been issued containing selections of his letters, many of them restricted to his relations with a single person, as Jacquin, B. de Jussieu, or Sauvages. But these only dipped into the extensive correspondence which is available, and the Swedish Government has aided the University, of which Linnæus was so distinguished a professor, to bring out a complete issue of all the letters known to be in existence, as part of the publications commemorating the bicentenary of the birth of the great naturalist in 1907. The editor was, naturally, Emeritus Professor T. M. Fries, who, four years earlier, had produced his monumental life of Linné and was steeped in Linnean lore and knowledge of his contemporaries. Six volumes had been brought out under his editorship when his death, early in 1913, closed his industrious career, and left the series of volumes less than half finished. These six belonged to the first section, devoted to letters to and from Swedes; a seventh was partly prepared, and the first volume of the second section, devoted to foreigners, was in course of preparation when the editor's life closed. The successor to Fries was Dr. J. M. Hulth, chief librarian of the University of Uppsala, but the time available for the subject so essential was obtained with difficulty by a very busy man. Nevertheless, we have here two volumes for a brief survey—volume 8 of the first section, extending from Kalm to Laxman, and a first volume of the second section, embracing the letters from Adanson to Brünnich.

Naturally, the latter volume attracts the non-Swedish reader, nearly the whole being in Latin, and the forty-nine writers include Francis Calvert, sixth and last Lord Baltimore (the owner of Maryland), Sir Joseph Banks, John Bartram, the early North American botanist of Philadelphia, Johann Bartsch, the close friend of Linnæus, who fell a victim to the climate of Surinam, Anna Blackburne, Herman Boerhaave, the celebrated Dutch physician, whose pathetic farewell to Linnæus is one of the most touching episodes in the Swede's career, and Patrick Browne, whose volume on Jamaica plants incited Linnæus to buy his herbarium for himself. Much might be extracted from these letters, but their comparative accessibility prompts our passing on to the other volume before us.

The forty-one letters from Pehr Kalm to his former teacher extend over 118 pages, more than half the volume, and are especially interesting. Kalm had travelled in Russia, whence the first letters were sent, but having undertaken a journey to North America, he, with an assistant, reached London in February 1748, and hastened the same day to report his arrival. His letters, written in Swedish, are couched in a fresh and lively style, and convey his first impressions. He hesitated to call upon the persons to whom he had been recommended till he should have acquired a better command of English, for though many wrote and spoke Latin, it was differently pronounced, and thus difficult to understand. In this he succeeded, as he was obliged to stay six months in London, waiting for a ship to America. He remarked on the milder winter of England compared with that of Sweden, and of the many plants which could stand out of doors unharmed. Soon we find him telling about his acquaintances. Philip Miller of Chelsea Physic Garden, and a special friend Richard Warner of Woodford (1711–1775), whose splendid garden yielded many seeds for Uppsala, John Ellis, Ehret the botanical artist, Dr. John Mitchell, and others were among the earliest of his acquaintances in London. Then the scene shifts to Philadelphia, where he was often with Bartram: "he lives about five miles from Philadelphia, a thoroughly good fellow and a strong Linnean; we have botanised a good deal round the country, and he has promised to send a quantity of rare seeds to Uppsala if he can manage to do so with the next ship." Kalm then turned his steps to Canada, and returned to Pennsylvania at the end of the year, again reaching London in the spring of 1751, and Stockholm a month later, passing on to Abo; in that University he had been appointed professor of economy, and on his return he took up the duties of his chair until his death in 1779, the year after the death of his old teacher. There are but few letters here from Linnæus, the reason no doubt being that, the recipient having sewn these letters into a volume, they probably perished in the fire of 1827, which destroyed the town and University of Åbo.

Martin Kähler (1728–1773), another of the Linnean pupils, had intended to travel to the Cape, but that intention was hindered by the Dutch. He therefore travelled in France and Italy, whence he returned in 1757. Magnus Lagerström (1691–1759) was a director of the East India Company of Göteborg (Gottenburg), and in that capacity was able to supply novelties to Linnæus; thirteen letters are here printed, but the letters to Lagerström are unknown. The last writer in the volume is Erik Laxman (1737?–1796), whose name is well known for his work amongst Siberian plants.

B. D. J.

Technology of Oils and Fats.

Chemical Technology and Analysis of Oils, Fats, and Waxes. By Dr. J. Lewkowitsch. Sixth edition, entirely revised by George H. Warburton. (In 3 vols.) Vol. 3. Pp. viii+508. (London: Macmillan and Co., Ltd., 1923.) 36*s.* net.

THE third and final volume of this well-known book deals principally with the technology of manufactured oils, fats, and waxes, as, for example, the refining of edible oils, the making of soap and candles, the purification of glycerine, oil hardening, and the preparation of polymerised, boiled, and oxidised oils. In appraising the value of these sections it must be remembered that the book deals essentially with the chemical aspect of these industries, and that in the few pages which can be spared to each it is impossible to attempt more than a general outline of the processes in common practice.

In particular, it is not part of the author's scheme to indicate on the more mechanical side of the industry which type of plant or process is at the moment generally in use in an up-to-date factory. One consequence of this treatment is that the accounts of the manufactures appear antiquated when read by one acquainted with practice, and the student of chemical technology trained on this book would justly be accused in the works of being too theoretical. On the other hand, it will be said there are numerous highly specialised text-books devoted to each of these subjects, and a brief summary of them from the more purely chemical point of view is quite enough to attempt. In this connexion it may be suggested that the book is rather overburdened with statistics.

An important section is that devoted to waste oils and fats: it may be defined as an essential function of the chemist in any industry to eliminate waste and to utilise the so-called waste products. In oil-refining, for example, much depends, from the economic point of view, on obtaining both a high yield of the refined product and the retention of the foots in a form in which they can be utilised. The respective values of soap stock, or soap stock fatty acids, often make all the difference in the refiner's profit. Latterly a number of alternative processes have been tried in this connexion, and some reference to them might well have been included in this volume.

The subject of hydrogenated fats is dealt with very adequately in the well-known book of Carleton Ellis, so that the author may be excused for devoting only ten pages to it. Of some interest is a paragraph referring to the use of such fats in the edible-fat industry, particularly on the Continent, and indicating doubt as to their suitability. Actually to-day hardened fats, particularly whale oil, are the most popular materials for edible fats on the Continent, and the refiners are willing to pay a price for the raw oil which puts it beyond the reach of the soap-maker, at whose instance, it may be remembered, the hydrogenation process was invented. The refined product, which is absolutely free from nickel and of a high standard of purity, has many desirable qualities, though from the most modern point of view the absence of vitamins must be held to be a disadvantage. Very little hardened fat, however, is used in margarine made in Britain.

Probably no section of the industries based on oils and fats has developed more in this country than the manufacture of margarine, owing in the main to the abnormal conditions imposed during the War. The advance in the technology of this industry has been enormous, both in the methods of refining the crude fats, in their selection and blending, and in the actual manufacture of the margarine, including the bacteriological processes of imparting the special butter flavour. The new factories are models of their kind, and triumphs of cleanliness and organisation. Unfortunately, the difficulties of distribution are such that the consumer cannot with certainty buy his pound of margarine in perfect condition unless his retailer is certain of a quick sale; and although the same difficulty applies to butter, more tolerance is extended to the older commodity.

A problem which is engaging an increasing amount of attention in the fat industry is that of texture. A fat, that is to say, a triglyceride, may either contain three of the same acid radicles or two or more different acid radicles, in which case it is spoken of as a mixed glyceride. A mixed glyceride has properties very different in regard to melting-point, consistency, etc., from a mixture of glycerides. Again, fats which, when separate, have similar properties which are satisfactory from the technical point of view, may have altogether different and far less satisfactory properties when mixed. Such theoretical considerations have an important practical bearing in the chocolate and biscuit industries.

Sufficient has perhaps been said to indicate how diverse are the problems to be found within the industries of the fats and oils, and how wide must be the scope of a work dealing with their chemical technology. Dr. Lewkowitsch's book has played no small part in aiding many an investigator to do his share in advancing the knowledge of them, and each new edition has reflected in turn the new information acquired. The newest edition is no exception to this and is replete with information, and it is with no wish to detract from its value that it is suggested that when the time comes for it again to be revised it may be advisable largely to remodel the plan on which it is built.

E. F. A.

Our Bookshelf.

(1) *Steam Turbines.* By Prof. W. J. Goudie. Second edition, rewritten and enlarged. Pp. xviii + 804. (London: Longmans, Green and Co., 1922.) 30*s.* net.

(2) *Modern Practice in Heat Engines.* By T. Petrie. Pp. xi + 264. (London: Longmans, Green and Co., 1922.) 15*s.* net.

(3) *Notes and Examples on the Theory of Heat and Heat Engines.* By John Case. Second edition, revised and enlarged. Pp. vi + 138. (First issued in 1913 as "A Synopsis of the Elementary Theory of Heat and Heat Engines.") (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1922.) 7*s.* 6*d.* net.

(1) Prof. Goudie's treatise was first issued in 1917, and the volume has become a standard work. Its value has been proved by teachers, students, and professional men engaged in practice. The book has been out of print for some time, owing to the author's desire to bring it up-to-date, and this has meant the formidable task of rewriting practically the whole work. To those acquainted with the first edition, the result will be found extremely serviceable, inasmuch as not only recent designs are included, but also additional matter is given bringing the theory up-to-date. The thoroughness with which the task of revision has been carried out is evidenced even in the numerical examples. The volume is now one which cannot be dispensed with by any one engaged in steam engineering.

(2) This book is divided into three sections dealing with steam boilers, steam prime movers (including steam turbines), and internal-combustion engines respectively. Some of the descriptive parts of the section on steam turbines are taken from the article written by Prof. Gerald Stoney and the author for the "Dictionary of Applied Physics" (Macmillan). The field covered is wide, and the book contains a large number of illustrations descriptive of the details of modern plants. Despite this, the author has succeeded in presenting as much of the theory as the average student requires in his college course. Students require a general treatment such as is contained in the present work, and they will also appreciate the fact that it contains no very difficult mathematics. There are a number of worked examples in the text, but it would be an improvement if some exercises were included for the purpose of enabling the student to test his knowledge.

(3) Mr. Case's volume of notes, worked examples, and exercises on the theory of heat engines will be helpful to many students. Most parts of the subject are covered, and those omitted do not present any particular difficulties.

The Pageant of Nature: British Wild Life and its Wonders. Edited by Dr. P. Chalmers Mitchell. (Complete in about 36 fortnightly parts.) Part 1. Pp. 72. Part 2. Pp. 73–144. Part 3. Pp. 145–216. (London: Cassell and Co., Ltd., 1923.) 1*s.* 3*d.* net each part.

The avowed object of this new publication is to provide the libretto to the play of Nature in Britain, and, by describing in clear and accurate language the varied phenomena which can be observed at all seasons of the year during almost any country ramble, to stimulate observation, to foster a love of Nature and, perhaps, to spur on to further independent discovery the keener and more gifted of its readers. It is essentially a book of Nature study, of observation in the field, of animals and plants in their natural surroundings. All the authors who have contributed to its pages—and there are no fewer than twenty in the three parts under notice—are well known for their admirable first-hand studies of wild Nature, in one or other of its many branches, with eye, field-glass, and camera and, may we add, with pen, and their articles are illustrated with original photographs taken either by themselves or by other equally skilled and enthusiastic Nature photographers.

It is perhaps invidious to make a selection from a number of articles all of which reach a high level of charm, accuracy, and simplicity; but special mention should be made of Dr. Francis Ward's delightful studies of otters and fishes, illustrated by a unique series of remarkable photographs of these animals taken under water, Mr. Edgar Chance's account of the egg-laying habits of the cuckoo, and Dr. Landsborough Thomson's articles on birds. The illustrations, in colour, photogravure and half-tone, are excellent on the whole. Particularly charming are four studies of the feeding of a cuckoo by its foster-parent, a meadow pipit, the work of Mr. T. M. Blackman. The reproductions of the photographs illustrating Mr. Chance's article, however, scarcely do justice to the originals.

The general editor, Dr. P. Chalmers Mitchell, in a short introduction, makes a strong appeal for the wider study of Nature in the field. This publication should go far to stimulate such study and to fulfil his hopes "to turn all our readers into watchful lovers of Nature."

Chambers's Encyclopædia: a Dictionary of Universal Knowledge. New edition, edited by Dr. David Patrick and William Geddie. Vol. 1: A to Beatty. Pp. vi+824. (London and Edinburgh: W. and R. Chambers, Ltd.; Philadelphia: J. B. Lippincott Co., 1923.) 20*s.* net.

A new edition of this work is welcome, for in spite of the many encyclopædias now available, Chambers's still holds its place. It is not exhaustive and does not claim to be a compendium of all knowledge, but at the same time it would be difficult to find any subject of general interest that finds no place in its volumes. The work has the further merit of easy reference, the subdivisions of the larger subjects being arranged in their respective places in the alphabet. The form and appearance of the pages which have been familiar to several generations are unchanged, but the matter has been revised, new articles being given where necessary and others brought up-to-date. New coloured maps, mostly by Bartholomew, have been added. That of North America needs a little revision in the north of Greenland, but for all general purposes they are excellent. The illustrations would appear to be mainly the woodcuts of earlier editions.

In one respect we might suggest an improvement in this useful work. Some geographical articles still contain descriptive matter that is unworthy of the advances in modern geography. Without any greater demands on space the descriptions of many countries could be made far more explanatory and graphic than is the case. Thus, in the article on the Balkans certain striking features, such as the central plateau, the fold ranges parallel to the sea, the two great corridors, and the gateways to the sea should be emphasised as being keys to many Balkan problems. The article as it stands is full of accurate information which might be better displayed. The same criticism is applicable to Albania and other articles. The low price of the encyclopædia is noteworthy.

Wind and Weather. By Prof. Alexander McAdie. Pp. 82. (New York: The Macmillan Company, 1922.) 1.25 dollars.

Prof. McAdie's little work is more historical than a current discussion of wind and weather. Much of the work is a dissertation on "The tower of the winds," which has been standing at Athens for the past twenty-two centuries. The allegorical figures of the winds given are reproductions copied from the frieze of the tower and the author has extemporised on them. Boreas, the north wind, is referred to as a cold and boisterous wind from the mountains of Thrace; Kaikias, the north-east wind, who carries in his shield an ample supply of hailstones, is supposed to be ready to spill them on defenceless humanity; Apheliotes, the east wind, is styled a graceful youth, with arms full of fruit and wheat; Euros, the south-east wind, is depicted as a cross old fellow, intent on the business of cloud making; Notos, the south wind, is the master of the warm rain; Lips, the mariners' wind, the south-west, said to be favourable for bringing the ships speedily into harbour; Zephyros, the west wind, is represented as a graceful youth, scantily clad, with his arms filled with flowers, while Skiron, styled lord of gusty north-west gales, carries with him a brazen fire bucket and is said to spill a generous stream of hot air on all below.

The latter part of the book is more practical and deals with the weather map and current meteorology, although in an elementary way, and this part seems to suggest that the author had American weather in mind rather than the weather in other parts of the world. C. H.

Text-Book on Wireless Telegraphy. By Dr. Rupert Stanley. Vol. 2: Valves and Valve Apparatus. Second edition. Pp. xi+394. (London: Longmans, Green and Co., 1923.) 15*s.* net.

In this edition a new chapter has been added describing high-speed signalling, recorder reception, short-wave signalling, and directional apparatus. In the author's opinion the two outstanding problems for research work are the elimination of atmospherics and the invention of a cheap system of high-speed reception able to withstand ordinary wear and tear. We agree with him that the well-established term "valves" should be used to designate the special vacuum tubes used in radio signalling.

In his preface the author points out that the development of radio signalling since 1918 has been much hampered owing to doubts about the validity of the patents of many of the methods and types of apparatus which were used in the War. The tedious delay in the establishment of broadcasting stations in Britain was largely due to disagreements between manufacturing firms on this question.

The Year-Book of Wireless Telegraphy and Telephony, 1923. (Edition for Amateurs.) Pp. xcv+824. (London: The Wireless Press, Ltd., 1923.) 6*s.* net.

The progress in the art of radio communication is so rapid that a new "Year-Book" is a necessity for all who wish to keep abreast of the times. We learn that in the United States nearly two hundred broadcasting transmitting stations are now in practically continuous operation and that the number of listeners is nearly a million. Canada comes next with fifty-three broadcasting stations, twelve of which are in Toronto alone. In France great progress has been made in perfecting high-frequency alternators. It is now possible to get a 500-Kilowatt 15000-frequency alternator which will have an over-all efficiency of 85 per cent. Latour has also shown how, by means of a 100,000-volt transformer and using two electrode valves as rectifiers, a pressure of 200,000 volts direct current can be easily and comparatively cheaply obtained. These high pressures are of great value as they open up new fields for physical research.

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.*]

Hafnium and New Zealand Sand.

THE account which was given in NATURE of February 10 (p. 195) of the very refractory substance which I obtained from a black titaniferous iron sand from New Zealand and believed to be the oxide of the newly discovered element, hafnium, requires now to be brought up-to-date. In that account it was mentioned that I had sent to Copenhagen practically all my purified material for X-ray examination and comparison with the preparations and specimens of the discoverers. Three specimens were sent: (*a*) the sand itself, (*b*) the cream-coloured substance labelled in 1918 "New Oxide," (*c*) the cinnamon-coloured oxide which resulted from the atomic weight determinations (Chem. Soc. Jour. for February, p. 312). The total amount of (*b*) and (*c*) was between 0·3 and 0·4 gram each and was all I had. The result of the first examination by Drs. Coster and Hevesy was to the effect that they were unable by X-ray spectral analysis to detect hafnium in any of the three specimens, and this I announced at the meeting of the Chemical Society on February 15.

Drs. Coster and Hevesy very kindly undertook a much more thorough and laborious examination, both by X-ray and by optical spectral analysis, especially of (*c*), which was naturally regarded as the purest sample of the oxide. They did this in the hope of finding some evidence of the presence of some of the other elements still missing, and in particular element No. 75, but in this they were unsuccessful. Their final report is that "The chief components are undoubtedly iron and titanium" with traces of manganese, aluminium and magnesium. As soon as I received this statement on March 19 I set to work on what remained of (*b*) and (*c*) to try to unravel the mystery of the high atomic weight which had seemed to prove conclusively that the oxide was that of an element with an atomic weight at least one and a half to two times that of zirconium (90·6). As the full analytical details and the steps by which the explanation was arrived at are given in the Journal of the Chemical Society for April, p. 881, I need not do more here than give the general conclusions. My further chemical examination of the cinnamon-coloured powder (*c*) agrees entirely with that of Drs. Coster and Hevesy in proving that it consists practically of oxides of titanium and iron, the latter only to the extent of about half a per cent. It is to the presence of this iron oxide that the cinnamon colour is undoubtedly due.

The "New Oxide" (*b*), however, seems to be a new oxide so far as chemical literature is concerned, but not the oxide of a new element. Further investigation showed it to contain a large percentage of silicon and that, so far as could be ascertained with the small quantity which I had, there seems to be but little doubt that it is a form of titanium dioxide in which part of the titanium is replaced by silicon. It is due in all probability to this replacement of titanium by silicon that the "New Oxide" owes its resistance to the attack of sodium bisulphate on one hand and caustic soda on the other.

The substance extracted from a New Zealand sand (while my specimens were in Copenhagen) by Dr. C. J. Smithells and Mr. F. S. Goucher (NATURE, March 24, p. 397) in the Research Laboratories of the General Electric Company, is entirely different from my "New Oxide." This is clearly proved by their own statements; hence their experiments with it have no bearing on the composition and properties of the substance isolated by me.

I gladly avail myself of this opportunity of acknowledging and thanking Prof. Bohr and Drs. Coster and Hevesy for all their courtesy and for the very great trouble they have taken to assist me in the elucidation of what seemed to be a real mystery. It is with sincere pleasure that I have just learned that they have succeeded in the difficult task of preparing hafnium compounds in a state of purity sufficient to enable them to locate its atomic weight between 179 and 181.

ALEXANDER SCOTT.

34 Upper Hamilton Terrace,
London, N.W.8,
April 25.

A Meteorological Disturbance of an Oscillatory Character.

A DISTURBANCE possessing a pronounced oscillatory character swept across the Gulf of St. Vincent, South Australia, on the morning of February 24. It may be of interest to put upon record its chief features.

At 5.10 A.M. those who were sleeping out of doors were rudely awakened after a stifling airless night (wind N.N.E., strength 0–1) by a sharp westerly squall. A lull was succeeded by a second squall about 7 minutes after the first; a well-marked line-cloud accompanied it, but no rain fell. The wind then dropped to a gentle S. breeze for a few minutes, but the approach of another splendidly developed line-cloud arching the horizon from S.S.E. to N.N.W. heralded another squall from the west. The upper atmosphere was almost cloudless, save on the western horizon, where an alto-cumulus layer drifted slowly from a northerly point. Again the wind went round to the S. and dropped, but a third line-cloud brought a fresh squall from the west.

The writer, observing from Glenelg, faced forty miles of sea stretching out to the westward, and it was a very fine sight to watch the unbroken lines of cloud, 2000 to 3000 feet up, approaching at a very great speed and stirring up an almost calm sea into momentary activity. The three clouds passed over within the space of a quarter of an hour, and were separated by approximately equal intervals of time. The wind which accompanied them was not very violent, probably between 30 and 40 miles an hour, but strong enough to cause the anchored yachts to swing round through 90° from S. to W. in a few seconds.

Though no further line-clouds were observed, the oscillatory character of the disturbance continued, and at two further intervals of 8 and 7 minutes respectively the squalls and vagaries of the shipping were noted. Eye observations were then suspended, but the writer is indebted to Mr. Bromley, Commonwealth Meteorologist for the State of South Australia, for traces of the automatic records obtained at Adelaide, 6 miles inland and E. of Glenelg, which show that the pulsations continued for about an hour altogether. The periodicity is especially well-marked in the barograph and wind velocity curves reproduced below; at first they keep remarkably in step, each rise in the barometer coinciding with an increase in wind velocity and vice versa, but there is some confusion in the velocity graph towards the end of the disturbance. The anemo-biagraph has been under suspicion of furnishing low readings, but it is also probable that the squalls lost something in intensity in travelling inland.

From the accompanying graphs (Fig. 1), the average period appears to be about 7·5 minutes; from the times of observation of the pulsations at Glenelg and Adelaide we calculate that they were travelling inland at approximately 30 miles an hour, and that they were between $3\frac{1}{2}$ and 4 miles apart.

The wind direction graph shows that, except for the initial squall, the changes in direction were neither so regular nor so pronounced in Adelaide as they were on the coast; as would be expected, the changes generally, but not invariably, coincided with the rise of the barometer. This graph records a series of small abrupt changes in direction, leading from W.S.W. to S.S.E., each pulsation, except the third, sending the wind round some 15°. This is very different from what was observed at Glenelg, where,

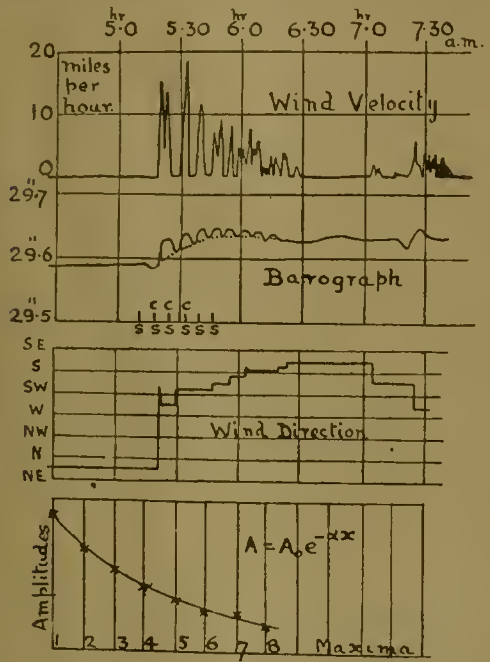

FIG. 1.—Records of an oscillatory meteorological disturbance at Glenelg on February 24. The times at which squalls and line-clouds were observed at Glenelg are marked S and C respectively. The autographic instruments were at Adelaide.

at any rate for the first 6 pulsations, the wind was S. during the lulls and W. during the squalls, rather as though there were intrusions of westerly air from above into a gentle S. current in the lower levels. It is difficult to account for these differences because the intervening country is flat, and both Glenelg and Adelaide are on the direct line of advance of the disturbance.

The barograph record shows first a slight depression and then a sudden rise of about 0·04 inch, something like half the amount observed in the case of some famous line-squalls. Later oscillations are less intense, the average of all being 0·02 inch from hollow to crest. From the original barogram I have measured the amplitudes of the successive oscillations, taking the dotted line drawn through the minima as datum line. Except for the last oscillation, which shows some irregularity, the amplitudes closely follow an exponential law. This is indicated in the final graph, where the abscissæ represent equal time intervals between successive maxima, and the ordinates the amplitudes, A. The full line represents the curve $A = A_0 e^{-\alpha x}$, where x is the time between maxima; the crosses mark the measured amplitudes on an appropriate scale. The logarithmic decay of the amplitudes suggests that viscous forces are involved in the phenomenon, though whether they act by diminishing the forces which occasion the pulsations, assuming that they are formed successively, or by diminishing the oscillations in their transmission, we have no means of ascertaining.

As regards the general meteorological conditions, the barometer had been falling for some time and the disturbance marked the beginning of a rise which continued for some hours. The Commonwealth weather-map compiled at 8.30 A.M. indicates that a shallow V-shaped depression, probably part of a monsoonal system, had recently passed across Adelaide from W. to E.; the axis then lay along a S.S.E.-N.N.W. line, which is rather curiously the direction along which the axis of the lines of cloud extended. Mr. Bromley kindly gave me access to a large number of weather charts and barograms, from which it appears that though unstable conditions are liable to arise with the passage of depressions, no evidence of regular pulsations occur except that above described and, also rather curiously, a comparatively feeble example on the previous day (11 A.M. February 23). In this case the oscillations increased in intensity as time went on. There were 5 pulsations with an average period of about 7 minutes, but the maximum amplitude was not more than 0·01 inch. Seven well-marked pulsations are shown upon the wind velocity graph, reaching 10 miles per hour.

W. G. DUFFIELD.

Dundrennan, Glenelg, South Australia,
March 3.

Phosphorescence caused by Active Nitrogen.

IN 1904, in the *Astrophysical Journal*, the present writer described the spectrum of the afterglow of active nitrogen, and showed that the vapours of mercury and other metals present in the tube participated in the afterglow. Some years later the present Lord Rayleigh showed that luminosity of the vapours of many substances is excited by active nitrogen.

Recently I have found that it also excites phosphorescence in a number of solid compounds. By opening a stopcock between the discharge tube and the pump, a jet of active nitrogen could be directed against a small quantity of the substance. In a number of cases phosphorescence was produced, which lasted for several seconds. The colour was green or bluish green, and the spectra all appeared to be continuous, except in the case of the first two substances named below, which showed characteristic bands. The results were as follows:

Strong.—Uranium nitrate, uranium-ammonium fluoride, zinc sulphide, barium chloride, strontium chloride, calcium chloride, cæsium chloride. These are arranged in the order of brightness.

Weak.—Lithium chloride, sodium chloride, potassium chloride, sodium iodide, potassium iodide, sodium carbonate, strontium bromide.

No effect.—Potassium sulphate, potassium nitrate, potassium hydroxide, mercurous bromide, calcium carbonate, calcium sulphate, calcium sulphide, lead chloride, cadmium iodide, magnesium nitrate, zinc chloride, manganese chloride, thorium oxide, chalk sugar, sulphate of quinine.

With the exception of the first three, the excited substances are little or not at all affected by light, but most of them are excited by cathode rays. It is remarkable that a specimen of calcium sulphide very sensitive to light was not at all affected. With the same exceptions, the effect was obtained only after partial drying, but appeared to be destroyed by complete calcination. Some of the substances did not always respond, even when taken from the same bottles as portions that did. None were chemically pure.

It seems possible that the phenomenon is due to chemical reactions with the active nitrogen, or it may be due to the presence of free electrons. An insulated electrode was sealed into the exhaust tube about a metre from the discharge tube and connected with an electroscope. When the latter was negatively charged little effect was produced by a stream of active nitrogen just past the stage of luminosity. When it was positively charged, it was rapidly discharged. When an uncondensed discharge was used with the same nitrogen, or the condensed discharge through inactive nitrogen, little effect was produced in either case. Recombination was apparently complete before the gas reached the electrode. As there must have been equal numbers of positive and negative ions, the loss of the positive charge must have been due to the greater mobility of the negative ions, and presumably they were free electrons. An attempt to measure the specific ionic velocities of the ions failed, on account of the electrostatic disturbances due to the disruptive discharge.

Under the conditions of these experiments, the line spectrum of nitrogen was not given by the light in the discharge tube. This indicates that molecular dissociation was small. The ions were probably for the most part molecular ions and electrons. The isolated bands in the first group which are the most characteristic feature of the spectrum of the active nitrogen afterglow must, of course, be due to molecular radiators. The afterglow depends upon the presence of a trace of oxygen (or some electronegative element) and is destroyed by the presence of more than a trace. It may be that in pure nitrogen there is no appreciable afterglow, because the great electron density favours rapid recombination. When there is an excess of oxygen, the electrons may all attach themselves to oxygen, and the final step may be the formation of nitric oxide, with the emission of Deslandres' third group of bands. If there is enough oxygen to remove most but not all of the electrons, recombination may go on slowly, the afterglow continuing while it lasts, the spectrum being due to the recombination of electrons with positive molecular ions. Of course the alternative is not excluded that active nitrogen may be monatomic and the characteristic radiation is emitted when it resumes its ordinary state.

E. P. Lewis.

Department of Physics,
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Active Hydrogen by the Action of an Acid on a Metal.

Evidence for the formation of active hydrogen from its positive ion in an acid has been negative. The reports of the latest workers in this field, Wendt and Landauer (Jour. Amer. Chem. Soc. 42, 930: 1920) show that there are certain difficulties to be met. The main one is to eliminate the moisture that accompanies a rapid evolution of hydrogen and at the same time not to destroy the active hydrogen if any were formed. If the velocity of the gas stream were too low, the active component would decay before reaching the sulphur. Then if the velocity were too high the moisture carried over would form a protecting film on the powdered sulphur and prevent the reaction between the two to form hydrogen sulphide.

During the work on the activation of hydrogen by corona discharge it was found by Wendt and Grubb (Jour. Amer. Chem. Soc. 42, 937: 1920) that active hydrogen combines with pure nitrogen to give ammonia. This method of testing for active hydrogen can be used to good advantage where moisture is carried along with the evolved hydrogen, since the spray does not prevent the contact of active hydrogen and the nitrogen.

If hydrochloric acid or sulphuric acid is dropped upon metallic magnesium suspended in such a way that the metal is at no time immersed or partly covered with any large portion of liquid, the drop of acid can react with the metal in the shortest possible time. This gives off hydrogen very rapidly, in fact almost explosively, and with a minimum quantity of spray. If this evolved hydrogen is brought in contact with pure nitrogen it is found that ammonia is formed very readily. The active hydrogen was then passed through a plug of glass wool before coming in contact with the pure nitrogen. The activity of the hydrogen still persisted as shown by the formation of ammonia. Therefore, the activity of the hydrogen cannot be due to ions or atomic gas. But Langmuir (Jour. Amer. Chem. Soc. 34, 1324 (1912)) has shown that monatomic hydrogen does not react with nitrogen to form ammonia. In view of this fact, if we allow pure nitrogen to escape at the surface of the magnesium where the hydrogen is evolved we find a maximum quantity of ammonia formed. The amount of ammonia formed increases with an increase in the rate at which the acid is dropped upon the metal. This, of course, means that the amount of the active component varies with the velocity of the gas stream.

If the acid is dropped on the metal very slowly and the evolved hydrogen passed through glass wool before coming in contact with nitrogen, no ammonia is formed. This indicates that the active hydrogen has reverted to the ordinary form before meeting the stream of nitrogen. The life of the active gas seems to be not longer than two minutes. This checks very closely with the life of triatomic hydrogen formed by other methods.

These results seem to substantiate the theory of Wendt and Landauer (Jour. Amer. Chem. Soc. 44, 510: 1922), namely, that triatomic hydrogen ought to be produced wherever atomic hydrogen is evolved. It is reasonable then to expect that a higher percentage of active hydrogen would be found in the gas evolved from the surface of the metal, than in the molecular hydrogen subject to electronic bombardment in a discharge tube. In the former all the hydrogen evolved goes through the atomic state, while in the latter case only a very small amount of atomic gas may exist at one time. The discharge would also destroy some of the active variety.

The preliminary results to determine the percentage of activation are in harmony with this theory. Further work is in progress to determine the quantitative relations of some of the factors involved.

A. C. Grubb.

Department of Chemistry,
University of Saskatchewan,
Saskatoon, Sask., Canada, April 2.

The Viscosity of Liquids.

I wish very briefly to supplement the remarks made in a previous communication on this subject in which I have suggested that the viscosity of liquids and its variation with temperature may be explained on the hypothesis that the liquid state of aggregation is composite in character; that is, is composed in part of molecules "rigidly" attached to each other as in a solid, and in part of molecules which are relatively mobile as in the gaseous state (NATURE, April 21, p. 532).

That the supposition made regarding the constitution of liquids is *prima facie* a reasonable one is, I think, clear from thermodynamical considerations. The liquid stands midway between the solid and the gas and has affinities to both. The volume of a liquid at temperatures slightly higher than the melting point is only moderately different from that of the solid, and hence the probability that many of the molecules are at any instant at the same distance from each other as in a solid is considerable. This probability may indeed be found from the latent heat of fusion of the substance. If W be the heat of fusion in ergs per mol, the number of molecules in the "rigid" and "mobile" states should be approximately in the ratio $e^{W/RT}$.

The mechanism of viscous flow of a liquid is perhaps clearest if we consider the case of a thin layer enclosed between two parallel plates, one of which slides over the other. When a steady state is reached, the "rigid" parts of the liquid move practically as complete wholes, and hence the effect of their existence is to diminish the thickness of the layer through which momentum has to be transported by the "mobile" molecules, and thus to increase the viscosity. As a rough approximation, this increase is in the proportion of the numbers of the two types of molecules. A more exact theory should take into account also the volumes occupied by the two types of aggregation and their changes with temperature.

The effect of pressure on viscosity of liquids would arise in two distinct ways. In the first place, we have a change of volume on fusion, and hence, by the Le Chatelier-Braun principle, the assumed dissociation from the "solid" to the "mobile" aggregation would be retarded by pressure, so that the viscosity should be increased. With substances such as ice which contract on melting, we have the opposite effect. In the second place, pressure diminishes the volume occupied by the "mobile" molecules, and therefore also the distance through which they have to transport momentum. This would increase the viscosity. At temperatures not much higher than the melting point, the first effect would preponderate. This is strikingly illustrated in the case of water, the pressure-coefficient of viscosity of which is negative up to 32° C., that is, even at temperatures much higher than that of maximum density.

C. V. RAMAN.

210 Bowbazaar Street,
Calcutta, March 15.

Green and Colourless Hydra.

IN NATURE of April 7 a short account is given of the interesting experiments made by Goetsch on the conversion of the green Hydra into a pale Hydra. Some years ago I observed what may be called a natural experiment of the same kind. At the south end of the tunnel that conducts the water supply of Manchester from Lake Thirlmere under Dunmail Raise to the Grasmere valley there is a small settling tank, and on the walls of this tank I found a very large assembly of milk-white Hydras. An examination with a pocket lens led me to the conclusion that they were only a white variety of the common *Hydra viridis*, and were probably the offspring of parents living in the tunnel. These white Hydras were evidently enjoying the full vigour of life.

SYDNEY J. HICKSON.

The University, Manchester, April 11.

Single Crystals of Aluminium and other Metals.

WITH reference to Prof. Porter's letter in NATURE of March 17, p. 362, the accompanying photographs (Figs. 1 and 2) may be of interest. They illustrate at a magnification of 100 diameters the type of fracture obtained when a drawn tungsten wire consisting of a single crystal is broken in tension. The fracture is

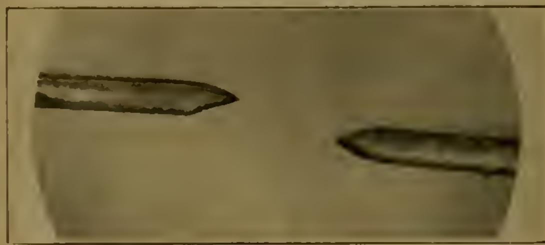

FIG. 1.—0·05 mm. single crystal tungsten wire broken in tension, showing reduction in diameter. (× 100.)

FIG. 2.—Same specimen photographed in a plane at right angles to that of Fig. 1, showing no reduction in diameter in this plane.

always of the wedge type, the wire being very greatly reduced in diameter in one plane while it suffers no appreciable reduction in the plane at right angles. The photographs show the same specimen after fracture taken from two planes at right angles. The diameter of the wire was 0·05 mm.

C. J. SMITHELLS.

Research Laboratories,
General Electric Co., Ltd.,
Wembley, March 20.

Stirling's Theorem.

A SMALL modification of the proof given by Mr. Strachan in NATURE of March 24, p. 397, leads to an asymptotic series for $n\,!$ rather more convergent than Stirling's. The symbol $n\,!$ standing, generally, for $\Gamma(n+1)$, we have

$$\log(n+\tfrac{1}{2})\,! - \log(n-\tfrac{1}{2})\,! = \log(n+\tfrac{1}{2}).$$

Hence, by Taylor's theorem,

$$\left(D - \frac{D^3}{2^2\,3\,!} + \frac{D^5}{2^4\,5\,!} - \ldots\right)\log n\,! = \log(n+\tfrac{1}{2}).$$

$$\therefore \log n\,! = \left(\frac{1}{D} - \frac{D}{24} + \frac{7D^3}{5760} - \ldots\right)\log(n+\tfrac{1}{2}).$$

$$\therefore n\,! = \sqrt{2\pi}\left(\frac{n+\frac{1}{2}}{e}\right)^{n+\frac{1}{2}} \times \exp.\left(-\frac{1}{24(n+\frac{1}{2})} + \frac{7}{2880(n+\frac{1}{2})^3} - \ldots\right),$$

the constant in the integration being determined as before.

Stirling's first approximation, $\sqrt{2\pi n}\;n^n e^{-n}$, makes $1\,! = 0{\cdot}922$, whilst $\sqrt{2\pi}\{(n+\frac{1}{2})/e\}^{n+\frac{1}{2}}$ makes $1\,! = 1{\cdot}028$ and so is a little closer.

H. E. SOPER.

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Highgate, N.6.

Selection and Segregation.

IN view of recent discussions in the columns of NATURE, the following remarks may be of interest.

Charles Darwin did not explore for himself the vast resources of the new territory which he discovered, nor did he traverse all the passages leading to it. He "allured to brighter worlds and led the way." In doing so it is possible that he did not arrive at the point of disentangling the qualitative from the quantitative implications of selection. It will be remembered that his theory was followed by long discussions on "What is a species?"

Natural selection is mainly qualitative, while specific differences are essentially quantitative. If Darwin can be said to have missed this distinction it was because he could not anticipate all the objections that might be brought to bear upon his marvellously fruitful concept. Moreover, quality and character often appear without any obvious separation, and in all cases the mind has to be addressed to the task of discrimination.

It is the province of Mendelism or genetics to deal with the analysis of unit characters and to exploit favoured individuals. Natural selection is concerned with the combination of characters, internal as well as external, and with the preservation of favoured races. Combination of characters gives quality to a genus; segregation of characters imparts novelty to a species. Mendelism and Darwinism clearly belong to different categories; though of course they meet on the common stamping-ground of heredity.

Natural selection is the directive force which controls the motive impulse of evolution and holds it within bounds. It thus becomes to our view the guardian of mutations, the custodian of change; that is to say, it provides an automatic control over the fitful mutations of the organism. The four pillars of organic evolution—struggle, survival, mutation, and adaptation—are properly orientated by natural selection. This operates in certain directions under certain conditions of climate and contact; it is the chain of events which assigns an organism to its place in Nature. Nevertheless, the simple thesis had not been excogitated before it was expounded by Darwin. It was a permanent gain to knowledge which can never be repeated, like the discovery of the circulation of the blood by Harvey and the biogenesis of reproduction by Redi.

Darwin gave us a theory of qualitative evolution by the natural selection of spontaneous variations in the open. Survival for an hour or for an æon implies unconscious selection for the time being. On the other hand, Mendel gave us a quantitative law of alternate inheritance of contrasting characters under culture. A single example, expressive of many, may serve to bring the distinction between intrinsic qualities and gross realities into crude relief.

Leaf-mimicry is one manifestation of interrelation of plants and animals, of which floral imitation and stick and twig shapes are others. It is a quality so intangible that it may be called into question even when most obtrusive. Individual observations are therefore of little moment until confirmed. The leaf butterfly (Kallima) and the leaf insect (Phyllium) resemble a leaf in different senses—the former vertically, the latter horizontally—the recognition of the resemblance in these classic examples being old-established. Some years ago ("Spolia Zeylanica," II, 1904) it was my privilege to bring to scientific notice for the first time the behaviour of a leaf fish (Platax) in Ceylon. Similar observations on a species of Platax in the Philippines have since been recorded by Dr. Th. Mortensen of Copenhagen. (*Vidensk. Medd. fra Dansk naturhist. Foren.*, Bd. 69, 1917, p. 63.)

Admitting the existence of leaf-mimicry in diverse planes and orders, we can only begin to explain it on the basis of natural selection, the leaf shape being desirable and attainable when other contributory factors are equal.

ARTHUR WILLEY.

Department of Zoology,
McGill University,
Montreal, April 1.

Distribution of Megalithic Monuments.

IN NATURE of March 31, p. 442, reference is made to Mr. W. J. Perry's speculations upon the builders of megalithic monuments. Perhaps you will be good enough to find room for some criticisms. There is a real danger that the scientific study of archæology may be overwhelmed by the tide of theorising which is now flowing so strongly in this country.

Mr. Perry believes that the builders of megalithic monuments chose to settle in those regions which furnished natural supplies of what the note in NATURE terms "precious metals and other valuables." If so, then why did so many of them settle in the Cotswolds, where natural flint is almost non-existent, and where no metals occur? In this region—in the counties of Gloucestershire and Oxfordshire—there are fifty-six Long Barrows, which Mr. Perry rightly includes within the class of megalithic monuments. Why are there more than twice as many Long Barrows in Gloucestershire alone as in all the other flint-producing counties of East and South-east England?—The East Riding of Yorks, Lincolnshire (none), Norfolk (none), Cambridgeshire (none), Essex (none), Herts. (one), Bucks. (none), Beds. (two), Oxfordshire (none in Chilterns), Surrey (none), Sussex and Kent (perhaps a dozen at most between the two). If it was flint that determined their settlement-areas, there is more to be found in any single *parish* of any one of these counties than occurs naturally in the whole of Gloucestershire! Why, further, is it that there is not a single Long Barrow within forty miles of Grimes Graves, the great Neolithic flint-mining district of East Anglia, and no megalithic monuments within a hundred miles?

But the greatest difficulty is in Mr. Perry's suggestion that the builders of megaliths travelled in search of metals. There is no evidence that the builders of British megaliths knew of or made any use of metals. Not a single fragment of metal has ever been found in a megalithic burial chamber in England, Wales, or Scotland. Accordingly, the opinion of archæologists for half a century has been that all megalithic burial-chambers (including those in Long Barrows) are neolithic; and there is no evidence of any sort to suggest that this opinion is erroneous, much less to prove it wrong.

Some controlling factors in the distribution of Long Barrows over a part of England and Wales were suggested in Ordnance Survey Professional Paper No. 6. The facts upon which my conclusions were based were presented fully, both in tabular form and upon a map (O.S. quarter-inch, Sheet 8). For this region the facts—about a quarter of them new to science—are not available elsewhere. When the survey of England and Wales is complete, it will be time to draw conclusions about the country as a whole. Until then, those interested would be serving science better by assisting in the collection of facts than by indulging in premature speculation.

O. G. S. CRAWFORD.

Ordnance Survey Office, Southampton,
April 14.

The Surface Movements of the Earth's Crust.[1]

By Prof. J. Joly, F.R.S.

THE land surface of the globe has been, for the most part, many times covered by the sea in the course of geological time. The mountain ranges of the earth, as now known, have only recently attained their present elevation ; other mountain ranges formerly existed which have now been all but obliterated by the remorseless effects of denudation.

It is important that we should study for a little what happens when a great mountain range is developed on the surface of the globe. There is a long period of preparation for the stately event ; a period many millions of years in duration. First, there are signs of unrest in the solid land of the continents. The sea rises on the coasts and transgresses on the wide lands within, very gradually stealing over the lower levels. This process may not be steady and continuous. There may be periods of retreat followed by periods of advance, but always the land, as a whole, goes on sinking deeper and deeper into the sea. Many millions of square miles may be covered with the shallow seas—perhaps to a depth of two or more hundred fathoms—so that a considerable portion of the land area of the globe may become sea before the downward movement ceases. This transgression is a slow process ; so slow and long-enduring that, while the submergence lasts, great depths of sediment accumulate in the transgressional seas.

Then at length there comes a resurrection. The land begins to emerge ; but not the old land which went down. Where the great accumulations of sediment had been, mountain ranges arise. In short, what arises from the ocean grave is a crushed and wrinkled world, shattered by faults and over-thrusts and exhibiting every evidence of great horizontal compression. One attendant of these events is the outbreak of volcanoes and floods of lava welling out of fissures in the earth's crust. The latter generally appear along western coasts, or to the west of the new-born mountain ranges.

These events draw to a close when the land has attained its former elevation, more or less. There is then a new era of geological history—a long era of organic progress, lasting many millions of years, during which minor oscillations of the crust and local deformation may occur. This is a period of active denudation. The last-born mountains are degraded by denudation, and their sediments collected into the great troughs or geosynclines, and the sublime but unreasoning sequence of events is repeated all over again.

Such has been in leisurely repetition the history of the earth. Certain world-revolutions are generally accepted—although geologists are not all agreed as to their number—as comprised in the period of 150 or 170 million years which the statistics of denudation and the record of thorium lead ascribe to the age of our era. Four or five world-revolutions appear to enter into that time interval. Thus 30 or more millions of years may, tentatively, be ascribed to the genesis and consummation of a world-revolution.

[1] From a public lecture delivered under the auspices of the Royal Dublin Society on March 7.

From these broad features of geological history it is evident that some source of unrest, acting upon the surface of the earth, which periodically recuperates its strength, runs a course involving an enormous expenditure of energy, and then dies down into quietude, must exist. What can this source of unrest be ?

In the science of isostasy we are confronted with the strange fact (for fact it undoubtedly is), that the lands of the earth—firm as they may appear—are yet floating like rafts or pontoons on a yielding substance far beneath. Now, the continents are built of rocks, such as granite, gneiss, sandstone, etc., and in the same way as the sea-water must be denser than the icebergs which float upon it, so the substance which buoys up the continents must be denser than granite and chemically similar materials.

We get a very sure guidance as to the nature of the sustaining substance in a direct and simple way by paying attention to the nature of the lava which is poured out in enormous volumes on the surface of the land during times of revolution. This substance comes up as a thin and very fluent liquid. It may flow for 50 or 60 miles over the ground before congealing. It solidifies to a black and heavy solid—basalt.

There appears to be no doubt—and in this many petrologists are agreed—that basalt is the primary rock-magma upon which the continents float and which buoys up the great oceans of the earth. Just beneath continents and oceans it forms a layer over the whole earth—a layer to which isostasy ascribes a depth of some 60 to 70 miles. This substance, basalt, therefore, plays a very important part in the surface history and physical phenomena of the globe. Primarily, and most important of all, we know that it contains a small quantity of radio-active substances. No basalt ever examined failed to reveal this fact. These radio-active substances continually evolve heat. We know of no conditions which can check, or in any way alter or modify, this ceaseless evolution of thermal energy. Hence we must recognise that in every cubic centimetre of this great magmatic ocean upon which the continents and seas float there is a source of slow thermal evolution.

Keeping in mind that the central problem to be solved with respect to the great land movements affecting the surface of the globe is to account for the great outbreak of igneous activity and crustal disturbance all over the surface of the earth every 25 or 30 million years, we naturally ask if the perennial supply of radio-active heat may not furnish the explanation.

The thermal properties of basalt under ordinary conditions have been fairly well examined. At a temperature of 1150° it softens, at 1225° it flows freely, forming a very mobile but heavy liquid. In passing from one state to the other there is a volume increase of about 10 per cent. of the initial volume. This may be a rather excessive value. It is not less than 6 per cent.

Now, the fact that the basalt in these great floods reached the surface in a fluid state is adequate proof that it was at a high temperature in the regions deep down from which it came. This is its condition generally all the world over during times of revolution. There are many reasons for believing that at the present time it does not and cannot generally exist in the fluid state; although deep pockets of the fluid magma must probably exist at all times throughout the magma-ocean and beneath the continents, there extends for a very long period after a revolution a shallow layer of the melted rock. Generally throughout the deep isostatic layer it possesses the characters of a plastic solid and is yielding enough for the continents to float upon it. The addition of a certain known quantity of heat to each gram of the highly heated basalt will convert it to the liquid state.

We know, as the result of many experiments, the quantity of radio-active substances in basalt. Samples from various great lava flows and volcanoes have been examined. There are certain variations in the quantities observed from one great flow to another. Taking a mean we can calculate the quantity of heat which would be generated, say, in one million years in each gram of the basalt. Briefly stated, the results of our investigation show that the heat accumulated in about 25 million years would suffice to turn the solid basalt, nearly at its melting-point, into a liquid.

The first effect of this change will be a considerable expansion in volume and corresponding loss of density and buoyancy. For, as has been stated, the solid basalt near its melting-point expands some 6 to 10 per cent. of its volume in changing to the liquid state. The result upon the continents is easily inferred. When a ship sails from the salt water of the ocean into a river of fresh water it sinks a little; so also the continents will sink a little. The waters of the ocean will therefore transgress upon the lands, advancing century after century as the basalt changes its state, as we know happens in periods preceding a revolution. Hence the earliest phase of geological change finds an explanation in the melting of the basalt which floats the continents.

But other consecutive consequences follow. For when, all over the earth, beneath continents and oceans, there extends a deep sea of melted lava, it is evident that conditions arise favourable to greatly increased volcanism both on the land and over the floor of the oceans.

The melted basalt will again lose heat and revert to the solid state. It may take 3 to 4 million years for this to happen, but happen it must. For liquids part with heat much more quickly than solids, just because circulation can go on in them. Now the basalt, where it laps against the rocky floor underlying the oceans, loses its heat far more rapidly than radio-activity can supply it. It probably melts away a good deal of the ocean floor in the process of parting with its heat. The ocean floor is very probably, almost certainly, also basalt. Possibly this floor becomes very thin indeed in the course of the long period during which the great ocean of lava is returning to the solid or plastic state.

It will be understood that the change of state has completely altered the conditions of heat-loss, the gain of heat per gram remaining the same at all times. The solid basalt can only lose heat by conductivity—a very slow process. Beneath the continents even this means of escape is almost closed, because the base of the continents possesses a high temperature, arising from the radio-active content of the continental materials themselves. Beneath the ocean, a few miles down, the conditions become much the same. Thus the solidified magma must conserve practically all its heat-gains. When fusion becomes general convection begins, as well as other movements later to be referred to. The escape of heat beneath the oceans becomes then relatively rapid.

But now notice the effect upon the continents of this reversion to the solid condition. When the basalt regains the solid state it also regains its original density; and the land regains its original buoyancy. The continents must now rise again to their former altitude above the sea. They are as ships passing from the river to the ocean. The waters which flowed in upon the continents during the slow process of the melting of the basalt must recede again as the basalt resolidifies. Hence a final great phase of geologic change finds explanation in the physical properties of the basaltic ocean and its inevitable thermal changes.

We can only discuss with any degree of definiteness the events progressing in the upper region of the great basaltic ocean. For the depth of this ocean is probably not less than 60 miles, and the pressures prevailing in such depths greatly modify the behaviour of substances experiencing accession or loss of heat, but there is no reason to believe that any effects to which reference has been made will be seriously modified. On the contrary, the effects, so far as we can infer them, of great pressure in the depths appear to bring events still more into harmony with geological observations and inferences.

From what has been stated we see that the reason for the long time intervals between the epochs of world-wide revolution is to be found in the smallness of the quantity of radio-active substances existing in the great sustaining magma supporting the continents and the oceans. On an average, it takes some 25 millions of years for the change of state to be brought about attending which the continents must sink and the waters transgress upon their surface. Then some 3 to 5 millions of years may be required for the stored radio-active heat to be again dissipated. The cycle is therefore accomplished in, say, 30 millions of years. These figures are given merely as suggestive of what might prevail. Various causes, which cannot be discussed, may modify them.

We live at a period immediately succeeding a very great world-revolution. The lava ocean has lost its heat of fluidity for the most part, and the continents float upon the basalt sea as upon a plastic or viscous body nearly at its melting temperature. These conditions are really very wonderful; but the explanation of our immunity is simple. The melting-point of the continental rocks is from 200° to 500° higher than that of basalt. Again, solid rock conducts heat badly. Hence little or no heat reaches us from the fiery ocean beneath.

We have next to consider if we cannot find an explanation of mountain-building and volcanic phenomena as involved in the changes we have been discussing. We know that the ocean tides are due to lunar and solar gravitational attraction. Oceanic tides are comparatively feeble phenomena; for not only is the ocean shallow and obstructed by land, but also water is a fluid of low density. But during times of revolution, just beneath the continents and oceans, there comes into existence a vast and far deeper ocean, composed for a great part of a highly fluid substance having a density three times that of water. We seem to have, therefore, good and sufficient reason for expecting greatly intensified tidal phenomena to arise during these times. So also a precessional force must act with intensified effect in periods of revolution. Both these forces tend to retard the surface crust of the earth in its diurnal rotation from west to east; that is, they tend to hold it back a little from partaking of the general easterly rotation of the globe. The effect is greatest in equatorial regions.

Fig. 1 shows, to an exaggerated vertical scale, a

Fig. 1.—Diagram of continental border-section W. to E.

portion of a continent seen in section, along with a part of a neighbouring ocean, both floating upon the basaltic magma. West is to left and east is to right. We must imagine that the lower, more viscous part of the magma possesses the full west-to-east angular velocity of the earth; but the continents and oceans and upper layers of the magma are, in virtue of the westerly forces just referred to, not moving quite so fast in that direction. They respond, in fact, to the forces urging them westward. We perceive that this involves, of necessity, an east-going force or pressure acting upon the submerged parts of the continents, and more especially upon the more deeply submerged parts; that is, upon the displacements required by isostasy to float the greater raised features of the continents.

The diagram is intended to illustrate the effect of the magmatic pressure with reference to mountain-building. We have already seen that mountain ranges arise where great depths of sediment collect for long ages. These accumulations may amount to several miles in depth; the sediments pressing down the crust as they collect.

It is well known that this process creates a linear area of weakness in the floating continent. We can picture what happens. The great load bends down the crust, forcing it deep into the hot magma. It becomes seamed with gaping vents and cracks, extending parallel with the axis of the trough into which the magma forces itself.

Now, if a horizontal force acts upon a continent affected with such an area of weakness, this part yields first and the sediments are crushed and forced both upwards and downwards. The part that rises up forms the mountain range; the part that is thrust downwards acts as compensation or buoyancy, which serves to float the mountain. The one adjusts itself to the other. The mountains slowly sink or rise till there is equilibrium. Thus, in course of ages, we get the floating mountain range. It will be perceived that the volume of the downward displacement is much greater than the mountain range. This is because the density of the crust does not differ greatly from that of the sustaining magma.

Such great ranges as the Cordilleras of North and South America rose up out of troughs of sediments in this manner. They were specially favourably oriented to receive the easterly pressure of the underlying magma, and, correspondingly, they are in many respects the greatest mountain developments of the globe.

However, while it seems easy to understand that the formation of mountain ranges directed more or less north and south might arise in this manner, it is more difficult to imagine chains of mountains like the Himalayas or like the Pyrenees originating in the west-to-east force arising from tidal or precessional effects. This brings us to the consideration of the possibility of the continents having shifted their relative positions during geological time.

Many are now weighing evidence for and against such extraordinary possibilities as to whether the Atlantic Ocean is not a comparatively recent innovation; whether New Zealand was not recently detached from Australia, and India from the eastern shores of Africa, and so on. Before this interesting question arose biologists and geologists generally got out of their difficulties by assuming the former existence of land connexions or "bridges" which subsequently "foundered" and disappeared.

Now, according to the present explanation of the surface movements of the earth, the foundering of such "bridges" would be difficult to realise; for they are of lower density than the basaltic magma upon which they at one time floated. So that it becomes very difficult to imagine the former existence of these bridges. Not only is this the case, but also the present theory certainly suggests that differential movements of the continents might quite possibly have taken place. I do not mean to convey that these supposed great movements *necessarily* arise out of our theory, but it is at least remarkable that a theory which appears to explain much—and on a basis which can claim to be more than merely hypothetical—should offer what may be regarded as a *vera causa* for continental drifting if other considerations require it. The continents during times of revolution become acted upon by forces tending to move them towards the east; and, what is even more relevant, these forces must of necessity be different in intensity from one continent to another. In fact, the magmatic drive applied to a continental mass depends upon the depth of its immersion and also on the existence of great displacements extending downwards into the deeper parts of the magma.

Another consideration in favour of continental drifting must be taken into account. The continents become acted upon by these forces only during the period of magmatic fluidity. We saw that this fluidity is ultimately lost, mainly in consequence of heat escaping through the ocean floor; this floor being probably more or less melted away during the process. It may be that the reduction in thickness of the ocean floor is carried so far as to remove what is really the main obstacle to differential continental movement—the existence of a strong and rigid ocean floor, holding the continents immovably fixed to one another.

We return for a moment to the problem of the elevation of such ranges as the Himalayas, which trend more or less east and west. We are now prepared for the possibility that the explanation of these events was due to a certain small amount of continental movement. It is a fact that tidal and precessional forces are greatest in equatorial regions. May it not have been that the great continent of Africa, experiencing the effects of this, rotated just a little, its southern extremity moving eastward; and so also for Peninsular India; so also for the Spanish Peninsula? A small turning movement, crushing the ancient geosynclines, would suffice. For, after all, the greatest mountains are but very tiny wrinkles upon the surface of this huge world.

The outflows of lava on the western coasts of the continents, or to the west of great mountain masses, or brought up by the downward faulting of rift valleys, to which I have already referred, seem to give us direct evidence of the magmatic pressures of which we have been speaking. The injection of lava into the great mountains, or its ejection from lofty volcanoes, finds explanation in the great volumes of included basaltic magma which are taken up in the crushed and shattered sediments of the geosynclines when these are floated up from the depths of the earth's crust.

In the foregoing remarks I have endeavoured to trace, on the basis of isostasy and radio-activity, the existence of cyclical changes, prevailing in the isostatic layer, which are in harmony with the observed recurrent world-revolutions. While a certain grand simplicity in the nature of these events, and the existence of a general resemblance between the character of one revolution and that of the next, permit of this treatment, it would be an erroneous inference that the physical events of historical geology are concentrated in the relatively brief periods of world-wide mountain-building. For in truth an endless succession of minor changes have affected the crust of the earth. Between the great revolutions transgressions of the ocean have occurred over considerable areas. Crustal warping, and even mountain elevation of lesser ranges and batholithic invasion of the crust, as well as renewed volcanism, have not been uncommon. All the events of the greater revolutions may appear locally, and always on a lesser scale.

In point of fact, these lesser, inter-revolutionary events are, probably, part of the primary phenomenon and owe their existence to energy concerned with the genesis of the former. For consider that during millions of years the continental crust, throughout every part of it, has been subjected to those same enormous stresses, vertical and horizontal, that served to uplift the Cordilleras to heights of more than 20,000 feet; and that, at the time when the floor of the ocean congealed around the continents and tidal effects died out, the vast volume of the land was left deformed by these great stresses, strained, often to fracture wherever rigidity prevailed, and with isostatic adjustments profoundly disturbed.

The inter-revolutionary periods of geological history must witness the readjustments necessitated by this accumulation of potential energy. Areas of low resistance—*i.e.* the geosynclines, the volcanic areas, or recently deformed regions—must experience the concentrated results. Moreover, all the conditions for very prolonged continuance of these minor activities exist. For there is no other way in which the accumulated energy may find relief save in crustal disturbance or readjustment. It will be slowly doled out for ages as the effects of denudation call upon it, or as thermal events give it occasion to intervene, for the cooling of the magma beneath the continents must be extremely slow. Sheets of melted lava must underlie them, throughout almost the whole of geological time, although deeper down there may be comparative rigidity.

It will be apparent from all this that there is nothing unaccountable either in the existence or nature of inter-revolutionary events. On the contrary, we may say that their absence would be highly unaccountable. Even more, I think that as we study these events we must conclude that they cannot represent more than a fraction of the stored energy attending a great revolution.

This leads to the energy question at large. Whence does it all come? To answer fully that question would lead us back over much of the ground we have already pursued. But as regards energy other than radioactive we may briefly answer: "From the rotation of the earth." And is it not adequate? Look at the diagram of an earth-sector (Fig. 2); with a floating

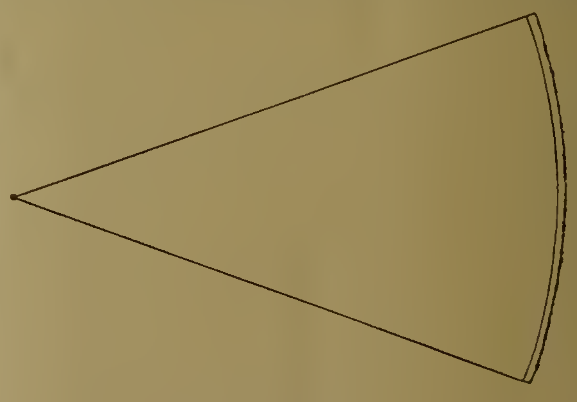


Fig. 2.—Earth-sector showing basaltic layer and continents to scale of radius.

crust 20 miles thick and an isostatic layer 70 miles deep. Consider how petty are the crustal energies contrasted with the stored energy of the globe, built as it is out of materials twice as dense as the continental rocks, and possessed, even to-day, of a surface velocity of 1000 miles an hour.

In its biological aspect how great and wonderful it all is! The living being working out his destiny on this poor raft, unknowing of the fiery ocean upon which his world is floating: unknowing of the inevitable sinking and uplifting which in truth largely control the destinies of his race. Death-dealing forces all around, and yet the light of life shining age after age upon the earth.

Water-Power in the British Empire.[1]

By Theodore Stevens.

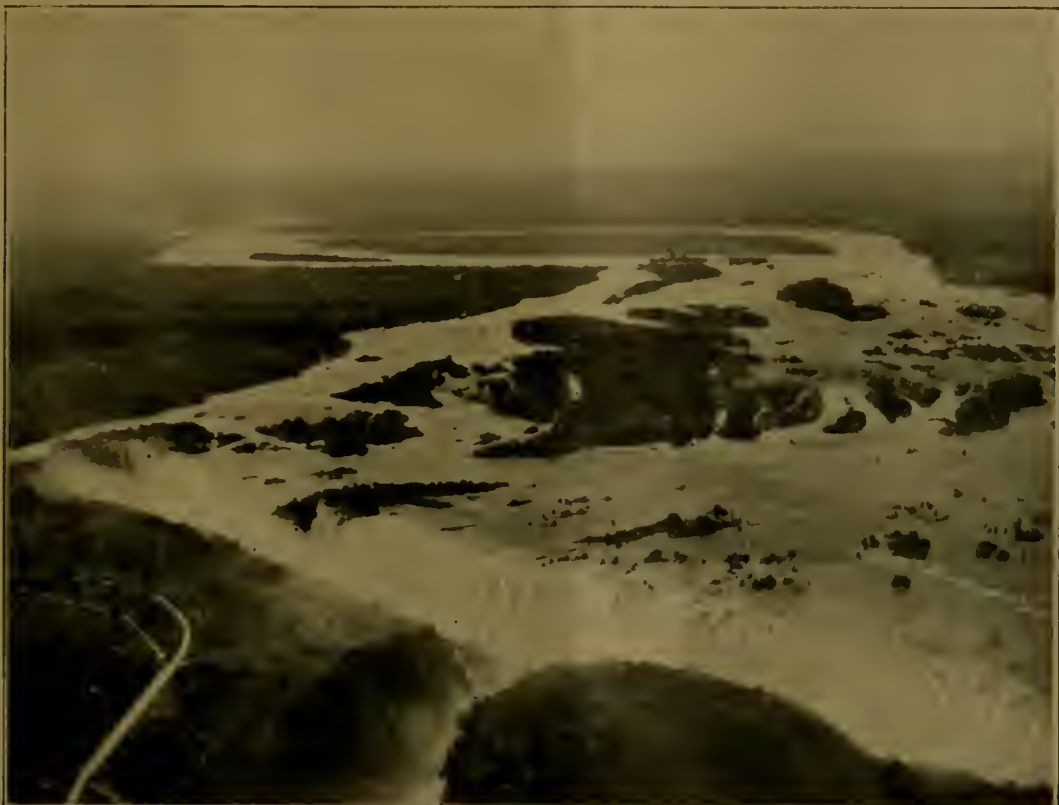
The Water-Power Committee of the Conjoint Board of Scientific Societies in its various reports has ably summarised the information on water-power available throughout the British Empire, and the Board of Trade Water-Power Resource Committee and Sub-Committee have dealt with the British Isles in a similar way. Canada has done more measuring of those resources than any other part of the Empire. Canadian water-powers in service, catalogued in Water Resources Paper Number 27, numbered, in 1920, 336 developed water-powers. Of these the summary, arranged by me under the different heights of falls, shows

43 were working with heads of water between 5 and 10 feet;
47 at heads between 11 and 15 feet;
84 ,, ,, ,, 16 ,, 30 ,,
84 ,, ,, ,, 31 ,, 70 ,,

With these figures before us, development of any head of water that may be available can be justified from past experience; but it is a great mistake to conclude that sufficient power can be developed from a stream until all the details of the problem have been fully studied.

There have been, within the last twenty years, water-plants installed in twenty different places, in every one of which after the capital was spent there was a rude awakening to the fact that the quantity of water necessary for the work undertaken was not available. A total of 25,000,000*l*. has been spent in those twenty places, and has proved financially unprofitable. Much more capital has elsewhere been profitably invested. Many other water-powers have proved successful. Enough has been said to show that reasonable caution necessitates efficient preliminary study before capital is invested.

Another note of caution refers to the distance that it is economical to transmit power. For example, it would not pay to generate hydro-electric power to supply a lighting load 75 to 100 miles away, if there is a coal-mine near the consumers' end of the transmission line; nor is it practicable to undertake to supply separate villages and farms on the line of a high-voltage transmission, because it costs many thousands of pounds to tap power from a high-voltage line, and the small consumption in village and farm cannot possibly pay the interest on this expenditure. It would be unnecessary to make such comments if this uneconomical arrangement had not been seriously advised by



[*Photo by Col. Sir H. A. Van Ryneveld, K.B.E.*

Fig. 1.—Victoria Falls, Rhodesia; view from the air.

The river at the fall is 1 mile wide and drops into a narrow gorge 400 feet deep.
The large model of Victoria Falls in the Imperial Institute, South Kensington, London, aids one to visualise this configuration.

[1] Substance of two lectures delivered at the Royal Institution on March 1 and 8, when illustrations of the important waterfalls in each part of the Empire were shown.

engineers whose experience evidently did not include such electrical details.

Seventeen years ago it was suggested that Victoria Falls (Figs. 1 and 2) would supply Johannesburg, and I have preserved a copy of the original prospectus of the company, including a map of the proposed transmission over a distance of 600 miles from the water-power across and into coal-mining districts. The company which was then floated has paid handsomely; but it wisely burns coal and says nothing about water-power. Even the hotel at Victoria Falls is lit by an oil engine. Similarly, if an examination is made of the super power zone in the United States, which embraces the great industrial area in the Eastern States, it will be found that it approaches within 200 miles of Niagara Falls, where many millions of horse-power run to waste, but it is not suggested that power should be derived from Niagara for that super power zone.

FIG. 2.—Victoria Falls; part of main falls. By courtesy of the British South Africa Company.

It is also true that Niagara power is delivered 270 miles from the Falls. The selling price (by Government, without profit) in bulk to the towns at that distance is three times the selling price for similar power near the Falls. There is always an excess of water at Niagara Falls. Under other conditions, for example, where summer flow is limited and cheap coal is available, it might be easy to prove that it is cheaper to generate electricity locally from coal than to transmit water-power so far.

Tidal-power fascinates every one who studies it; and when our coal supplies are much nearer depletion than at present, it may be utilised on a large scale. The Ministry of Transport published a scheme (since withdrawn) for developing tidal power on the river Severn, and said that the power was so vast that it exceeded "all the potential sources of inland water-power in the United Kingdom put together." But two and a half times the power proposed for development in the Severn exists in other parts of the British Isles, where it is free from the irregularity due to the variation in the times of the tides, and it can be developed for 5,000,000*l.* less in first cost than the estimate for that tidal power; the estimate, in my opinion, was not half enough to do the work specified.

We might allow this scheme to rest in peace, since the Geddes axe was first sharpened for use on the promoters of it; but, from time to time, it is brought forward as practicable. If one reads the Interim Report on Tidal Power by the Board of Trade Water-Power Resource Committee, it will be seen that nothing more costly than further investigation and study of the complications involved was recommended by that Committee; and the Electricity Commissioners dissociated themselves from any knowledge of the power-house, two miles long, with railway trains using the power-house as an economical bridge across the river.

We have an example of a corporation electricity supply being changed from a financial burden on the rates to a satisfactorily profitable undertaking in the report of the Chester electrical engineer, Mr. S. E. Britton, by utilising a small head of water (which varies from nothing up to 8·5 feet, because the tide comes up to the water-power plant's discharge). In seven years, on a capital of 56,000*l.* in steam-plant, there has been a relative loss of 15,000*l.*; while 18,000*l.* capital invested in the water-plant has shown 82,000*l.* profit, leaving a net profit of about 67,000*l.*; but it is essential to realise that this water-power cannot be utilised for a satisfactory statutory supply of electricity in Chester without the steam-plant to produce current from coal when the water-power is not available (due to high tide or to insufficient flow in the river).

Shawinigan in Canada is an example of a beautiful waterfall concerning which, I believe, it was an American who wrote:

> At every waterfall two Angels stay,
> One clothed in rainbows, the other veiled in spray.
> The first, the beauty of the scene reveals;
> The last revolves the mighty water-wheels.
> And there those two fair sisters ever stand,
> Utility and Beauty, hand in hand.

To-day, instead of standing to be admired, "Beauty" is to be found voluntarily undertaking some useful work.

The water at Shawinigan Falls now flows down inside pipes. Where, in the days of Beauty, only an occasional sportsman visited the falls, is to be found to-day a town of 12,000 inhabitants, amply provided with work and wages by the water-power which is utilised for various electro-chemical manufactures, as well as for supplying the cities of Montreal and Quebec with electricity.

In Ireland the writer carried out surveys of the power available in the largest rivers, for the Irish Hydro-Electric Syndicate and for the Water-Power Resources of Ireland Sub-Committee under the chairmanship of Sir John Purser Griffith, and has shown that it would be practicable in an average year thus to supply a demand three times as great as the present demand in the whole of Ireland for electricity, and has recommended and shown the economy of linking up this supply to all important towns and cities; utilising existing steam-electric stations to supply current when, owing to drought, one summer's flow of the rivers is too far below the average summer flow. The combination is like that at Chester, but on a much larger scale.

Suppose we allocate part of each of the rivers Shannon and Erne to the manufacture of carbide and of nitrogen fertilisers and operate this plant as fully as the flow of water permits; with an average output we could make in a year fertilisers containing 20,000 tons of nitrogen. Each of these works would be of the size recommended as economical by the Nitrogen Products Committee of the Ministry of Munitions.

It is not definitely known how much nitrogen fertiliser can be utilised within Ireland; but there are markets for carbide and for nitrogen fertilisers outside Ireland, so any excess over home requirements could be exported at a profit.

The nitrogen in various compounds used in a year in the world amounted to 694,600 tons[2] pre-War and 1,219,000 tons post-War (1919). There is nothing excessive in recommending fixation in Ireland of 3 per cent. of the world's annual pre-War consumption of nitrogen.

There would be work throughout the year, but more people employed at the chemical works in winter-time than in summer. It is well known that about 10,000 workers leave Ireland every summer to do farming in Scotland and England and return to their more economical life in Ireland during the winter-time. For some of those there would be thus provided winter work in their own country; while, of course, there would be employment throughout the year for an appreciable number.

There are nitrogen fixation plants near Niagara and at various other places in the world. About half of the pre-War consumption of nitrogen was in the form of native nitrate of soda. Among the many important applications of water-power, the one in Tasmania, where the Electrolytic Zinc Co. of Australasia, Ltd., utilises 30,000 horse-power from the Tasmanian Government Plant for the preparation of high-grade zinc, is worthy of especial mention.

More attention should be paid to the selection of industries that require large amounts of power, and to their establishment at sites where suitable water-power is available. We cannot recall too often the history of Niagara's development. Before electricity was a commercial form of energy, capital was invested (during the years 1853 to 1861) in making provision for direct water-power; in 1861 it was ready, but it ran to waste for ten years before the first consumer arrived in 1871. It was not until 1894 (forty-one years after the commencement referred to) that a profitable amount of power was utilised. Water-power is the cheapest form of energy when fully utilised twenty-four hours in the day.

[2] American Electro-Chemical Society's Proceedings, Volume 34.

Obituary.

Prof. J. D. van der Waals.

WITH Johannes Diderik van der Waals, who died on March 8 at Amsterdam, at eighty-five years of age, one of the great figures in the history of modern physics and physical chemistry has passed away. His thesis on the continuity of the liquid and gaseous state was a revelation in the study of fluids, the remembrance of which was to glorify the golden jubilee of his doctorate next June, and after establishing it he continued for some forty years to apply his efforts to the same subject, marking the steps of his success by further brilliant discoveries. When the Nobel Institute honoured this lifework, van der Waals was still occupied rounding off the comprehensive views science owed to him. For about half a century he was in the front of the workers in the domain he had opened. In the ten years which separate us now from then his forces began to give way, and later bodily and mental sufferings, borne with modest resignation, set in. At last, only short visits allowed us to show to the venerated and beloved friend, whose heart we felt remained unchanged, what he had done for us.

Van der Waals was born on November 23, 1837, at Leyden. He was a self-made man who took advantage of the opportunities offered by the University which he later honoured by his curatorship. It was not until he was thirty-six years of age that he wrote his thesis. With it he himself opened the period of Dutch science, which his elder friend Bosscha and he hoped to be one of the results of secondary education. In 1877, van der Waals became a professor at Amsterdam, and began to exert his great influence on the development of Dutch physics. One of the characteristics of his highly admired teaching was the introduction of Gibbs's great work to the chemists. I vividly remember as an example of it how Bakhuis Roozeboom, to whose first experiments the Leyden physical laboratory had been in the position to give some help, obtained results, which were inexplicable until van der Waals came to give him the key to it in Gibbs's doctrine of phases, his deep insight clearing the way for Roozeboom's brilliant work on the phase rule.

Very much was done by van der Waals for the Royal Academy of Sciences at Amsterdam. For twenty-four years he was the soul of the Board, and in 1896 he even accepted the secretaryship of the Academy, a post which he filled until 1912. Here as everywhere else he showed a never-failing unselfishness and high conception of duty. We owe to him the modern form of the Proceedings and their English translation, which he directed, both with an incomparable energy. The great efforts he bestowed on these periodicals have been well rewarded by the effect their stimulating influence had on Dutch science.

The scientific work of van der Waals forms a monumental whole of a special style. Characteristic of it is the intuition by which he introduced happy simplifications and approximations leading to a high degree of qualitative agreement of his theories with Nature, which in the case of the law of corresponding states rose even to a surprising quantitative approximation.

The first idea of the image of the fluid state which was gradually developed by van der Waals came to him when he combined the kinetic theory of gases with the determination of the cohesion in Laplace's theory of capillarity. With the aid of very happy approximations he built up the kinetic theory of the fluid state. Such a simplification gave in the first place the calculation of a molecular pressure which represents the cohesion, and the result of the calculation led him to the profound conception that the molecules of the gaseous and the liquid state are identical and exert identical forces. Secondly, he accepted as by inspiration an exceedingly appropriate form for what would be the outcome of the calculation of the kinetic pressure at higher densities. The simple equation of state which he obtained in this way reproduced the well-known diagram of Andrews-Thomson, as the representation of a series of stable and unstable states of mechanical equilibrium. It gave a deeper insight into the continuity of the liquid and gaseous state as well as a luminous explanation of the critical phenomena. It stood even the crucial test which van der Waals only with apprehension undertook to apply to it; that is, the calculation of the critical data of carbon dioxide of Andrews from the deviations from Boyle's law according to Regnault. Finding correct values for these meant a great discovery. The various thermal properties of fluids treated until then in different chapters of physics proved now to be at least approximatively contained in a single equation with only two specific constants, the volume and the attraction of the molecules, their molecular weights being given by their composition. Later researches have proved, more and more, the greatness of the genius which led van der Waals to his equation of state. Even now it is the most appropriate one to discuss qualitatively the properties of fluids.

Directly from this can be derived the second great discovery of van der Waals, namely, that it is only necessary to introduce the reduced values of volume, temperature, and pressure obtained by dividing the values of these variables by their critical values into the equation of state, to reduce this equation to the same equation for all substances. Simple as this substitution is, it took seven years before it was arrived at, and then only by van der Waals himself, who had been wrestling for a long time with the explanation of the deviations between his equation of state and reality. He had followed many false tracks in order to find some regularity in the deviations of the different substances, and had reached the conviction that to compare substances they have to be considered in corresponding states; that is, at the same values of the reduced variables. At that moment he found the law of corresponding states. Its scope is far wider than that of the equation of state. It involves the bold idea that the thermal properties of all substances can be derived from those of a single one simply by numbers of proportionality; and, what is marvellous, the law approximates more closely to Nature than the equation from which it is derived. How much I was under the influence of its great importance as much as forty years ago may be best judged by my taking it then as a guide for my own researches. It has had a great effect on the work of liquefying the permanent gases (in his thesis van der Waals predicted that air had to be cooled below −158° C. to be liquefied, which has proved nearly correct) and of attaining the *nadir* of temperature.

This cannot be better illustrated than with the words of our deeply mourned Sir James Dewar in a letter to me, expressing that van der Waals was "the master of us all," "whom we cannot honour too much." All substances, except for small differences, appear in the light of the law of corresponding states, as van der Waals expresses it, as individuals of the same kind. He liked to direct attention to the fact that his friend Dewar had proved that, taking temperature as a measure, hydrogen was, according to his prophecy, a dwarf. To read to van der Waals a report of the experiments which proved that helium, though a very small dwarf, was yet well shaped, was a happy moment in my life, especially as the report showed the profit derived from van der Waals' law of corresponding states and at the end referred to his words that "matter would always show attraction."

As all normal substances are almost copies of the same model, van der Waals was anxious to bring his equation of state in closer approximation to this general model and to understand the differences between the various substances. To his pondering on the influence of association into double molecules on the deviations, we owe his theory of binary mixtures, which covers a yet vaster and more varied field than his previous discoveries. It is especially this theory to which, in connexion with the beautiful work of our deeply mourned Kuenen, I owe the strong ties which united me to van der Waals. For many years I went to his study at Amsterdam for a "monthly private course," that is, a consultation on the Leyden work, and I found van der Waals always at his table filled with papers, with the portrait of his wife, who died at an early age, on the chair in front of him. In these hours it often occurred that from an unpublished calculation he could rightly predict some error to be found in the diagrams of the experiments; and it is from them that I have got an idea of the amount of work from which his genius came to his intuitions.

It would occupy too much space here to refer in detail to the work of van der Waals, which groups itself around these three great discoveries. I can only point out that he tried to combine the theory of specific heats with that of the equation of state, and that in the end he was occupied with the very interesting problem of the influence of the conglomeration of greater number of molecules; that of quasi-association. Rounding off in this way the chapter he wrote in the history of science, he gave us, at the same time, a glimpse of that chapter which the next generation has to write, containing a rational application of quantum considerations in van der Waals' theory of the fluid state.

Not less than the extraordinary intellectual gifts which made possible his great life work, his friends admired his severe culture of the ideal and his noble character. We remember the pious heart, in whose friendship we rejoiced, and with a feeling of deep sorrow at the loss of his presence, we give him here the tribute of our profound gratitude.

H. Kamerlingh Onnes.

Dr. Arthur Latham.

The medical profession has lost a somewhat striking personality by the death of Dr. Arthur Latham at the relatively early age of fifty-six. The son of a former Regius professor of medicine at Cambridge, who still survives, Dr. Latham was brought up in a cultured and scientific atmosphere, while his Oxford degree implied the double advantages of the two older English Universities. He was elected assistant physician to St. George's Hospital in 1898, and there soon showed his ability in teaching and his always masterful and dominating personality. A man of precise logical thought and of great determination, he could ill tolerate indefiniteness of view and indecision, and it is not surprising therefore that he had enemies as well as cordial friends.

Whatever Dr. Latham undertook, he made himself thoroughly acquainted with, and it was fortunate that the award to him of a prize for an essay on a tuberculosis sanatorium early determined the chief trend of his work. Although sanatoria for consumptives have not achieved all that was expected of them, this has been largely owing to their misuse under the pressure of the administration of the National (Health) Insurance Act, patients being sent in large numbers to sanatoria, for whom treatment in hospitals was indicated. Dr. Latham contributed other papers and small books on tuberculosis; he was a member of the Departmental Committee on Tuberculosis, which laid down the lines on which the state anti-tuberculosis measures were to be carried out; and in many other ways helped to bring the anti-tuberculosis crusade to its present advanced condition.

Of Dr. Latham's value as a medical politician, of the important work which he did to secure the firm beginning of the Royal Society of Medicine, this is not the place to write; but the memory of his clear and incisive speaking, arising out of logical thinking, of his pertinacious advocacy of great causes, and of his success in advancing the interests of preventive medicine, will not soon die.

We regret to announce the following deaths:

Prof. Gustav Köhler, director of the Mining Academy, Clausthal, for the years 1887–1914, and who had taught there since 1880, at the age of eighty-four.

Sir Shirley Murphy, vice-president of the Royal Sanitary Institute and other scientific societies, and for twenty-two years Medical Officer of Health for London, on April 27, aged seventy-four.

Dr. Alfred Scholl, a director of the Agricultural Experimental Station, Münster, and deputy-editor of the *Zeitschrift für Untersuchung der Nahrungs- und Genussmittel*, on February 12, at the age of forty-six.

Mr. H. J. Seaman, for many years general director of the Atlas Portland Cement Co., New York, who was responsible, with Hurry, for introducing the use of coal dust in rotary tube furnaces for the burning of clinker, on February 9.

Current Topics and Events.

Prof. de Sitter, who is to give a lecture at the Imperial College of Science and Technology on May 7, on "Problems of Fundamental Astronomy," and will lecture also at Manchester on May 9, and at Edinburgh on May 18, was a pupil of Kapteyn's, who was invited by Gill in 1896 to work for a time at the Cape. He made determinations of the parallaxes of several southern stars with the heliometer. For his thesis for doctor of science at Groningen he presented a "Discussion of the Heliometer Observations of Jupiter's Satellites." He has continued these researches and developed a new method for treating the mutual perturbations of the satellites, and is still engaged discussing photographs taken at the Cape and Greenwich for the determination of the necessary constants. After his return to Groningen Prof. de Sitter participated in a number of Kapteyn's investigations dealing with the dimensions and structure of the stellar universe. British men of science owe a debt to Prof. de Sitter for giving during the War, before Einstein's work reached England, three papers in the Monthly Notices of the Royal Astronomical Society which presented to English readers an account of the generalised theory of relativity. Prof. de Sitter has made important contributions to this subject and has examined the various cases where any astronomical verifications may be obtained.

In an article in the April *Quarterly Review*, Lord Ernle writes on "Victorian Memoirs and Memories." His account of Huxley runs as follows: "Mrs. Asquith, who describes a meeting with Huxley at Jowett's, and remarks that he had about him little of the *juste milieu*, does not appear to have been favourably impressed. But Huxley was not always the gladiator. To me he was irresistibly attractive, because I fancied that I had caught a glimpse of his true outlook on life. When I think of his destructive criticism, I see again the arabesque with which he had adorned the side of the first page of his article on 'Lux Mundi.' Up the margin ran a vine-clad trellis: on the top crowed the cock of theology, and towards him crept the fox of science. I remember also discussing with him one of his numerous controversies—I think the Gadarene swine. With the impertinence of comparative youth, I expressed surprise at the quantity of vinegar and mustard which he mixed with the discussion of questions that to many people were matters of life or death. 'My dear young man,' he answered, 'you are not old enough to remember when men like Lyell and Murchison were not considered fit to lick the dust off the boots of a curate. I should like to get my heel into their mouths and scr-r-unch it round.' A wistful smile lit up his plain rugged face, as he added: 'And they never seem to reflect what a miserable position mine is standing on a point of Nothing in an abyss of Nothing.' The world saw much of the first mood, little of the latter."

The council of the Zoological Society of London presented an eminently satisfactory report for the last year at the annual general meeting on April 30. There has been an increase of nearly two hundred in the number of fellows; the additions to the collections are more numerous than in the preceding year, the result chiefly of the receipt of H.R.H. The Prince of Wales's Nepal and Malayan collections; the attendance at the gardens maintains a very high level; and the financial position of the Society is thoroughly sound. The Proceedings have reached their pre-War standard as to bulk, the number of illustrations, and the promptness of publication; but the issue of Transactions has not yet been resumed. An appreciative reference is made to the work of Mr. Pocock, whose resignation of the post of superintendent has lately taken effect. Zoologists will learn with regret, akin to dismay, of the decision of the Society to cease publication of the "Zoological Record," owing to the inadequate support received. The Society has rendered an invaluable service to zoological science throughout the world in having undertaken the responsibility of the Record for so long a period, and it is a matter of grave concern that its efforts have met with so poor a measure of support. The council reports that excellent progress has been made in the construction of the new aquarium, and it is hoped that this will be ready for opening in the autumn of the present year. A favourable report is given of the durability of the coloured labels, painted in fusible enamel on tiles, which were introduced last year on the results of special experiments, and their use is to be extended as rapidly as possible. The scheme for the instruction of school teachers, which has been in operation since 1910, has been suspended for the present, as a large proportion of the London school teachers have now taken advantage of it.

THE results of a conference of veterinary authorities convened by the Government of India at Calcutta in February last were summarised in the *Times* of April 17. Anthrax infection in the case of East Indian wool, hair, and hides is so serious that special attention has been directed to the subject. Yet, according to the official returns, anthrax is a rare disease in India. The cost of disinfecting wool is greater than its present value, and the conference came to the decision that the agencies for notification of the disease in India must be improved, and that much skilled research and inspection are needed among the living animals in the country, if the disease is to be attacked at its seat. Surra, a disease of horses and camels, is now known to be due to a parasite of the group that gives rise to sleeping sickness in Africa. Tuberculosis is proved to be a frequent cause of loss of cattle, but little is known as to its prevalence. In short, "veterinary education, veterinary research, and veterinary legislation and administration in India are wholly unsatisfactory, and it is urgently to be hoped that the Government of India will give immediate and serious attention to the conclusions reached by the Conference."

THE meeting of the Illuminating Engineering Society on April 24 was notable for the large number of representatives of associations concerned with the printing industry which attended to join in the discussion of Mr. L. Gaster's paper on the lighting of printing works. Employers and employees joined in expressing appreciation of the importance of adequate illumination, and the Rt. Hon. C. W. Bowerman, who opened the discussion, contrasted the attention that is now being paid to the subject with the neglect of past years. Mr. Gaster dealt very fully with the lighting of compositors' benches, machine-rooms, etc., showing a number of attractive photographs taken by artificial light, and mentioning the values of illumination recorded in each case. It would appear that recent experience favours the use of general lighting as compared with the "patchy" local lights formerly customary, and pictures were shown of rooms flooded with light up to 10-12-foot candles. It was interesting to learn that the cost of lighting in general forms only about 1 per cent of the wages bill in this industry, which employs highly skilled labour. Mr. Gaster also put in a word for the requirements of the journalist, who is called upon to read manuscripts at high speed, and whose work often demands scrupulous accuracy. Proper lighting, both for proof-readers and in the editorial rooms, is most important, and it is singular that in some large newspaper works this matter is neglected, although the section of the building devoted to the actual printing processes may be relatively well lighted.

PROF. J. A. FLEMING, University College, London, has been asked by the British Broadcasting Company to broadcast an appreciation of the scientific work of Sir James Dewar on Friday evening, May 4, at 9 P.M. The message may be heard by all having a wireless telephone set which can pick up from 2 LO in London.

THE eighth Guthrie lecture of the Physical Society of London will be delivered on Friday, May 11, at 5 o'clock, at the Imperial College of Science and Technology, by Dr. J. H. Jeans, who will take as his subject "The Present Position of the Radiation Problem."

PROF. J. B. LEATHES, professor of physiology in the University of Sheffield, will give the Croonian lectures of the Royal College of Physicians in June; Prof. E. H. Starling, the Harveian oration on St. Luke's Day, October 18; and Dr. John Hay, of the University of Liverpool, the Bradshaw lecture in November.

IT is stated by Dr. Theiler in the *Chemiker-Zeitung* for March 20 that pure methyl alcohol is quite non-poisonous. The poisonous nature of impure wood spirit is due, not to the methyl alcohol it contains, but to the impurities which are present, such as allyl alcohol, allyl acetate, acetone, and their very poisonous homologues.

ACCORDING to the *Chemiker-Zeitung* for March 22, Prof. G. Tammann, of Göttingen, has received the Bakhuis-Roozeboom medal of the Royal Academy of Sciences, Amsterdam. This medal is conferred for researches connected with the phase rule, and was presented, for the first time, to Prof. F. A. H. Schreinemakers of Leyden in 1916. Prof. Tammann will receive the medal personally at the May sitting of the Academy.

The fourth of the series of lectures on physics in industry, being delivered under the auspices of the Institute of Physics, will be given in the hall of the Institution of Electrical Engineers, Victoria Embankment, W.C.2, on Wednesday, May 9, at 5.30 P.M., by Dr. J. W. Mellor, of Stoke-on-Trent, who will deal with "The Application of Physics to the Ceramic Industries." Sir J. J. Thomson will preside. No ticket of admission is required.

At the anniversary meeting of the Royal Society of South Africa, held in Cape Town on March 21, the following officers were elected: *President*: Dr. A. Ogg; *Hon. Treasurer*: Dr. L. Crawford; *Hon. General Secretary*: Dr. W. A. Jolly; *Members of Council*: Mr. K. H. Barnard, Dr. J. W. Bews, Dr. J. P. Dalton, Dr. J. D. F. Gilchrist, Dr. S. H. Haughton, Dr. J. S. v. d. Lingen, Dr. T. J. Mackie, Dr. A. W. Rogers, and Dr. S. Shönland.

An address on "The Worth of Science" will be given at a meeting of the London Branch of the National Union of Scientific Workers on Tuesday, May 8, at 6 P.M., at the Birkbeck College, Bream's Building, E.C., by Sir Richard Gregory. The chair will be taken by Mr. C. S. Garland, M.P. The meeting is intended primarily for members of the Union who are scientific workers in Government departments, but a cordial invitation is extended to non-members interested in the work of the Union, especially those in public employment.

Applications are invited by the Secretaries of the Royal Society for a Moseley research studentship, value 300*l.* per annum, "for the furtherance of experimental research in pathology, physics, and chemistry, or other branches of science, but not in pure mathematics, astronomy, or any branch of science which aims merely at describing, cataloguing, or systematising." The appointment will, in the first instance, be for two years, but it may, in exceptional circumstances, be extended. Further particulars and forms of application are obtainable from the Assistant Secretary of the Royal Society, Burlington House, W.1. The latest date for the receipt of applications is Friday, June 1.

The eleventh International Physiological Congress will be held in Edinburgh, on July 23-27, and the following officers have been appointed: *President*, Sir Edward Sharpey Schafer; *Treasurer*, Prof. A. R. Cushny; *Secretaries*, Prof. G. Barger and Prof. J. C. Meakins; *Assistant Secretary*, Miss Dorothy Charlton. Those who desire to be enrolled as members are requested to forward their names and addresses, together with the amount of their subscription (25*s.*), to Miss Charlton, Department of Physiology, University, Edinburgh, who will send on request particulars of hotels and lodgings, and all other necessary information. Opportunities will be afforded for the exhibition of physiological apparatus.

The Minister of Health has appointed the following committee "To investigate the comparative value, for the therapeutic purposes for which cocaine is at present used, of various possible substitutes, and the evidence as to risk, if any, of such substitutes becoming drugs of addiction": Dr. J. Smith Whitaker, Dr. N. G. Bennett, Dr. R. W. Branthwaite, Dr. T. Carnwath, Dr. J. H. Chaldecott, Dr. H. H. Dale, Mr. T. B. Layton, Dr. G. F. McCleary, Mr. R. Foster Moore, and Sir William Henry Willcox. The secretary is Dr. E. W. Adams, Ministry of Health, to whom all communications relating to the work of the committee should be addressed.

The Postmaster-General has appointed the following committee to consider broadcasting: Major-General Sir F. Sykes (chairman); the Hon. J. J. Astor; Mr. F. J. Brown, Assistant Secretary of the Post Office; Sir Henry Bunbury, Controller and Auditor-General of the Post Office; Viscount Burnham, chairman of the Newspaper Proprietors' Association; Dr. W. H. Eccles, president of the Radio Society of Great Britain; Sir Henry Norman; Mr. J. C. W. Reith, general manager of the British Broadcasting Company; Sir William Robertson; and Mr. C. Trevelyan. The terms of reference of the committee are: "To consider (*a*) broadcasting in all its aspects; (*b*) the contract and licences which have been or may be granted; (*c*) the action which should be taken on the determination of the existing licence of the British Broadcasting Company; (*d*) the uses to which broadcasting may be put; (*e*) the restrictions which should be placed on its user or development."

An article on "Botulism in Scotland" which appeared in Nature of March 24, p. 415, referred to the difficulty, due to breakages, in heating glass containers for potted meats, so as to secure preventive sterilisation. Dr. G. R. Leighton, the author of the report described in our article, says on this subject: "I find it is a common experience in the trade that glass containers cannot be heated above boiling-point without the risk of a good many being broken." Mr. R. L. Frink, director of research of the Glass Research Association, in a letter to us, urges that such statements are scarcely justified, and do not take into account "the strenuous efforts that are being made to establish glass in its proper place as the most suitable container for foodstuffs." He adds: "Within the last month I have received information dealing with those properties and the use of glass as a food-container requiring pasteurisation and sterilisation (the latter being at temperatures of 230°-250° F.). It is shown that of more than 400,000 gross of containers used, there was less than 0·25 per cent. breakage, causing a loss not exceeding two-thirds of that suffered by the use of tins." Also as "the contents of tins are susceptible to fermentation or decomposition there is great danger that ptomaine may be propagated or that soluble salts of lead may exist in the contents."

The Geological Survey of New South Wales is fortunately able to continue the publication of its valuable Records. The last two numbers, vol. x.

pts. 1 and 2, have been received, and contain some important communications, such as:—"Palæontologia Novæ Cambriæ meridionalis; Occasional Descriptions of New South Wales Fossils," No. 8, and presumably the last, from the pen of the late R. Etheridge, junr.; "A Census and Index of the Lower Carboniferous Burindi Fauna," by Dr. W. N. Benson; "Note on the Occurrence of Graptolite-bearing Beds of Ordovician Age at Yalgogrin and Ariah Park," by L. F. Harper; "Materials for the Study of the Devonian Palæontology of Australia," by Dr. W. N. Benson, in which is included a useful bibliography, and a "Census and Index" which will prove invaluable to students.

An article on "The Present Situation in the Radium Industry," by H. E. Bishop, in *Science* of March 23, gives an interesting account of the influence which the discovery of a rich deposit of radium will have on supplies in the future. Rich ore was discovered near Elizabethville in the province of Katanga in 1913, during prospecting work by the Union Minière de Haut Katanga, a Belgian corporation. Before any developments of the find could occur the War broke out. The secret was so well kept that no word reached the outside world until a very large plant for radium extraction had been erected at Oolen in Belgium. In spite of the fact that the ore is transported 2000 miles down the Congo, across the ocean to Antwerp, and then by rail to Oolen, its richness allowed of radium preparations being put on the market in the early part of last year at a considerably lower figure than that at which it has been maintained for some years by the American companies. As a result of conferences between the representatives of the American companies and the Belgian, a joint selling organisation has been formed. We learn from the article that the question of a tariff to protect the radium industry of America has been discussed, and apparently the decision taken that the preferable policy is one by which a lower price of the commodity will lead to its more widespread use.

Circulars Nos. 120 and 121 of the U.S. Bureau of Standards, Washington, are of interest as showing the wide scope of the work of the Bureau and how the interests of various sections of the community are looked after in America. No. 120 describes the "Construction and Operation of a Simple Home-made Radio Receiving Outfit," and No. 121 describes the "Construction and Operation of a Two-circuit Radio Receiving Equipment with Crystal Detector." They are both clearly written, and can be obtained from the Government Printing House at Washington for a few cents. The apparatus described can all be made at home. The movable coil tube, for example, can be made from a round cardboard box which contained table salt, and the outer cardboard cylinder can be an old oatmeal box. For a set which will receive messages from a high-power radio telephonic station up to 75 miles, or from a medium station up to 10 miles distant, the cost varies from 10 to 15 dollars. The simple apparatus described is suitable for every-day work, but mention is made that parts of the apparatus may possibly be covered by existing patents. A test buzzer for finding the most sensitive spots on a galena crystal is regarded as a necessity, and is included in every estimate. As crystals are quite cheap, insensitive crystals should never be used.

We have received the first five parts of the *Japanese Journal of Chemistry*, issued by the National Research Council of Japan, Tokyo, 1922. The president of the Council is Baron K. Furuichi, and the vice-president Prof. J. Sakurai, and there is a committee of publication. As we have already stated in these columns (April 7, p. 478), the Council issues a journal devoted to chemistry and another to physics, each in ten numbers annually, a journal dealing with geology and geography quarterly, and a proceedings and journals covering botany, zoology, medical sciences, astronomy and geophysics, and engineering, occasionally. Communications relating to these publications should be addressed to the Secretary, National Research Council, Department of Education, Japan. The editorial matter, and most of the papers, in the numbers of the *Journal of Chemistry* which have been received are in English. Besides original papers, there are abstracts of papers which have been published in Japanese journals. The standard of the publications is high, and the journals will be useful to European readers in keeping in touch with much first-class work now appearing in Japanese journals.

The Ministry of Public Works, Egypt, has published the report on the work of the physical department for the year ending in March 1922. Dr. H. E. Hurst, controller of the department, records that in spite of an inadequate staff the scope of work has widened in several directions. Rainfall returns were received from thirty stations in Egypt, eighty-nine in the Sudan, forty-five in Uganda, fifty-five in Kenya, five in Abyssinia, and one each in Aden, Somaliland, Zomba, Seychelles, Mauritius, and Cyprus. Arrangements have been made to start a new station at Dangela in north-west Abyssinia. Regular readings of river discharges were made at sixteen stations on the Nile, Atbara, Rahad, and Dinder. The discharges of the White Nile and Main Nile in February 1922 proved to be the lowest on record. The level of the Bahr-el-Gebel and the White Nile fell below the bottom of many of the gauges, and new methods had to be devised quickly to mean the levels. The meteorological service has been active. During the year Egypt had twenty-six and the Sudan twenty-nine meteorological stations. This was an increase of four; new stations have been opened at Suez, Delta barrage, Giza, Makwar, and Bir Abu Tif in the Sinai peninsula. The station at Mansura was closed. Of the Egyptian stations, that at Helwan is of the first order and fourteen are of second order. Investigation of the upper air continues at Helwan and elsewhere in co-operation with the Royal Air Force. The report contains records of other valuable work.

Messrs. W. Heffer and Sons, Ltd., Cambridge, have sent us a copy of their catalogue (No. 223) of 381 publishers' remainders. The copies are as published, *i.e.* not second-hand, and the reductions in many cases are considerable. Several books of scientific interest are included. The list should be seen by all who are in search of book bargains.

The Oxford University Press announces "Race Problems in the New Africa," by the Rev. W. C. Willoughby, in which will be discussed the relation of Bantu and British in the parts of Bantu Africa which are under British control. The same house will also publish "A Practical Hausa Grammar, with exercises, vocabularies, and specimen examination papers," by Capt. F. W. Taylor.

Messrs. A. and C. Black, Ltd., have in preparation new editions of vol. 2 of Dr. D. H. Scott's "Studies in Fossil Botany" (Spermophyta) and vol. 1 (Radiography) of Dr. R. Knox's "Radiography and Radio-therapeutics." In the first-named work the account of the so-called "Seed Ferns" (Pteridosperms) has been completed, rearranged, and for the most part rewritten. A number of families are described more fully than in the previous edition. The systematic position of the Pteridosperms is discussed, and a new view is taken of this question differing widely from that formerly maintained. In the second work the opportunity has been taken to bring the text up-to-date in regard to the progress of radiography, and to include a chapter on the author's recent work on gallstones. The volume also includes some appendices, one consisting of a report of the committee which was appointed to consider the protection of the operator from the effects of over-exposure to X-rays or radium.

Our Astronomical Column.

The Present Condition of the Giant Planets.—Some surprise was created at the meeting of the Royal Astronomical Society on April 13 by a paper from Dr. Harold Jeffreys in which he raised doubts about the generally accepted view that these planets are still at a very high temperature. He made an estimate of the amount of heat that would have been radiated by Jupiter in the course of a period of three hundred million years, on the assumption of a high temperature throughout this period, finding that it exceeded the probable initial supply; he drew a further argument from the low densities both of primaries and satellites, in the case of these four planets, concluding that they are built of less dense materials than the inner planets. While there was some agreement with these views at the meeting, there were several expressions of dissent. The very energetic processes that are obviously going on upon Jupiter can scarcely be ascribed to the very feeble solar radiation, which is only one-twenty-seventh of that received by the earth. Moreover, if Jupiter were formed of material of the same density as that forming its satellites, the much greater force of gravitation upon it would produce a higher density through compression, unless counteracted by heat or some similar agency. A further argument was drawn from the spectra of these planets photographed at Flagstaff; these all showed broad absorption bands, implying dense atmospheres.

It will be remembered that recent studies of Jupiter by the bolometer indicated no sensible heating effect; but this was ascribed at the time to a dense absorbing atmosphere rather than to an actually cool interior. In any case, it is always in the interests of truth for any weighty evidence that can be put forward against accepted results to be considered seriously in an impartial frame of mind.

Nature of the Spiral Nebulæ.—Recent discoveries on the rapid rotational motion of the spiral nebulæ, which has been revealed both by spectroscopic determinations of velocity in the line of sight, and by Dr. Van Maanen's discussion of photographs taken at an interval of some years, has shown that these objects are not directly comparable with the Galactic system. Their distance can be roughly estimated by comparing the angular and linear rotational velocities; it is of the order of a few thousands of light-years, which is far too small to permit us to regard the regions of uniform luminosity as being due to the combined light of millions of stars. Prof. Lindemann read a paper before the Royal Astronomical Society on April 13 in which he put forward the view that they are simply vast collections of cosmical dust, the diameters of the particles being of the order of 10^{-4} cm., that being the size for which light-pressure is most efficient.

In other words, as Prof. Turner expressed it in the discussion which followed, the spirals are regarded as the dustbins of the stellar system, into which all interstellar dust is swept by the light-pressure exerted by the stars. An explanation would thus be afforded of the remarkable freedom from dust of the interstellar spaces, which was brought out by Prof. Harlow Shapley's work on the globular clusters, and by other researches. Prof. Lindemann suggested that the light of the spirals was simply reflected light from the whole stellar system; their spectrum, which seems to be a blend of all the stellar types, is in accord with this view. The case would be analogous to that of the Pleiades nebulæ, which give the same spectra as those of the stars which they surround. Prof. Lindemann showed that on certain assumptions as to the thickness of the spirals, reflected starlight would account for the observed luminosity. The mass of the spirals would still be of the order of thousands of suns, and they might still be regarded as providing the material of future clusters.

Variable with a Remarkable Spectrum.—Dr. Harlow Shapley, in Harvard College Observatory Bulletin No. 783, describes the spectrum and the light variation of the tenth magnitude star H.D. 81137 (R.A. 9^h $18{\cdot}7^m$, Dec. -52° $8'$) as "both of unprecendented types." The spectrum belongs to the type Ma of the Harvard Classification, and contains five well-marked bright lines or bands coinciding with some of the strongest bright lines in the spectrum of η Carinæ, the origins of which are unknown.

The spectrum of η Carinæ is not classified by the Harvard observers but described simply as "peculiar," but it is probably a hot star. H.D. 81137, as it is classed Ma, is comparatively a cool star, so this is an example of a cool star exhibiting bright lines of a hot star nature. Approximate positions of these lines are $\lambda\lambda$ 4244, 4287, 4352 to 4358, 4414 to 4416, and 4452 to 4457.

The light curve showed a steady rise from 9·8 in 1890 to 9·2 in 1901, and has since steadily dropped, reaching 10·1 in May 1922, so the period of variability is long.

Research Items.

THE COIN COLLECTION AT HULL.—The Wilberforce House Museum at Hull contains an interesting collection of local coins and tokens, a catalogue of which by Mr. W. Sykes has now been published. A mint was established in the city by Edward I. in the year 1300, and two silver pennies, the only variety of coin, so far as is known, struck in this mint, are included in the collection. The inscription on the obverse is "Edwardus Rex Angliæ Dominus Hyberniæ," "Edward, King of England, Lord of Ireland," and on the reverse "Vill. Kyngeston," "Town of Kingston-upon-Hull." The collection of seventeenth century tradesmen's tokens is fairly complete, containing 30 out of 34 examples.

THE ROMAN WALLS IN NORTHERN BRITAIN.—The study of the Roman Walls has been considerably advanced by two papers published in the Journal of Roman Studies (vol. xi. part 1, 1921). In the first paper Mr. G. Macdonald discusses the building of the Antonine Wall, with a fresh study of the inscriptions; in the second Mr. R. G. Collingwood enters upon the history of Hadrian's Wall. These two exhaustive papers must form the basis of all later attempts to discuss the problems involved in their construction. Mr. Collingwood suggests that Hadrian's Wall was not, as one is apt at first sight to suppose, a military work intended to give tactical advantage to troops on the defensive, but a police work, intended to facilitate the patrolling of the frontier-line against unauthorised crossing.

THE NORTHMEN IN ENGLAND.—An admirable article in the April issue of the *Quarterly Review*, by Mr. Reginald Lennard, shows that so far from the warrior West Saxon kings like Alfred the Great being the protagonists in this period, it was the intrusion of the Northmen which changed the fabric of Anglo-Saxon society. This view is based partly on the work of sociologist-historians like Maitland and Vinogradoff, but mainly on that of philologists like Mr. Allen Mawer, who have been working at the place-names of northern England. The extent of the Norse vocabulary on place-names is a new and important discovery, and the writer points out that in the early English kingship, taxation, and the judiciary, the Norse influence was great. The explanation suggested is that the Norsemen gained by travel and commerce an experience denied to the home-loving Saxon. They were champions of freedom: the growth of the English manor was largely influenced by them: and in art the Norse spirit is now widely recognised.

OUR TEUTONIC FORBEARS.—Under this title Prof. F. G. Parsons contributes a valuable article, in which, from the point of view of an anatomist, he describes in the *Times* of April 14 the results of the exploration of Saxon burial-grounds at Margate, Mitcham, and Bedford-on-Avon. At Margate the dead are found buried in regular rows, as in a modern cemetery, a habit the Jutes brought with them from the continent, where the so-called "row-graves" or *Reihengraben* have been long recognised in North-West Germany. The Jutes' burials may be always recognised from their habit of burying an earthenware bottle, usually near the face of the dead: it possibly contained ale or mead for the refreshment of the ghost. From the arms and other adornments it is certain that at Mitcham and Bedford-on-Avon the sites were occupied by pagan Saxons, long-headed, long-faced members of the Nordic race, though every now and then a broad head of Mid-European origin turns up, warning us that the Angles, Saxons, and Jutes were not an altogether pure race. The average height 5 ft. 6 in. contrasts with 5 ft. 9 in. of the average Englishman of our day. The well-worn teeth show that much of his food consisted of grain, roughly ground by soft stones; he suffered terribly from chronic rheumatism or osteo-arthritis, and among the men fractures, often wonderfully well set, appear; old head injuries are common, showing the rough, adventurous life they led. Most of them died before 40, and the proportion of adolescents between 15 and 20 was very great.

SOCIOLOGICAL ASPECT OF FATIGUE PROBLEMS.—In *Psyche* (vol. iii. No. 3) Miss Mona Wilson discusses the "Problem of Industrial Fatigue" in Great Britain. She states that she wishes to treat the subject from a sociological, rather than from a technical point of view, because, however valuable the results of scientific research into fatigue may be, they cannot be adequately utilised without a fundamental change in the relations between employer and employed. Until recently no systematic study of industrial fatigue had been undertaken in Great Britain. The War, however, with its urgent demands for maximum output, compelled the Government to consider the problem of fatigue in relation to output, and ultimately the Industrial Fatigue Research Board was established to study the human side of industry. Fatigue showed itself to be a very complicated problem, and already it has had to be considered in relation to problems of vocational selection, training, and motion-study, as well as to the more obvious problems of hours of labour, speed of production, division of the working day. As the problems are too detailed for a single body to undertake them all, the writer suggests that while the Industrial Fatigue Research Board might initiate lines of inquiry, some of the better organised trades might form Joint Research Associations responsible for their own investigations, and that for this purpose they might co-operate with the Institute of Industrial Psychology as well as with the Board. General conditions for working such Associations are given, and in particular there is emphasised the need for giving guarantees to the employees that, should the result of the research work be to employ fewer people, those displaced will be absorbed elsewhere. The article is worthy of careful consideration both by technical researchers, who sometimes tend to become absorbed in a too narrow aspect of their investigations, and also by the student of social problems, who not infrequently tends to neglect the scientific problems inherent in them.

NEW EOCENE MOLLUSCA FROM TEXAS.—Appended to "A geological reconnaissance in the Gulf coastal plain of Texas near the Rio Grande," by A. C. Trowbridge, is an account of the "New species of Mollusca from the Eocene deposits of south-western Texas," by Julia Gardner (U.S. Geol. Surv. Professional Paper 131-D). They are few in number but decidedly interesting. A subspecies of *Ostrea alabamiensis* seems the most abundant form, and Cucullæa one of the more conspicuous. There is a doubtful example of Cerithium, which on the plate has been styled "Melania?" and a handsome nautiloid referred to the genus Enclimatoceras, although as pointed out by Foord in 1891 (Cat. Fossil Cephalop. Brit. Mus., Pt. ii.), this should have borne the prior name of Hercoglossa.

GEOLOGICAL RESEARCH IN SWEDEN.—Volume 18 of the Bulletin of the Geological Institution of the University of Uppsala (1922) bears the name of

Hjalmar Sjögren as its editor; but it also records his death from apoplexy, early in the year. The long list of his papers, from 1877 onwards, and the appreciation so aptly written in English by Prof. A. G. Högbom, show how greatly geological science has lost by the passing of one who did not cease to be an investigator when he could also afford to be a patron. The Bulletin is prefaced by a portrait that will record Sjögren's truly noble personality for friends in every quarter of the globe; it is difficult to realise that he was already well on his way towards his seventieth year. The volume covers even a wider range than usual, from the crystallography of amphibole to Cretaceous mosasaurs from Texas. We may specially note G. Frödin's elaborate study of the highlands of central Sweden, including the Åre district, written in German, and his paper in English "On the analogies between the Scottish and Scandinavian portions of the Caledonian mountain-range." In the latter, as the result of his studies of deep continuous sections in Sweden, the author urges that the Moinian and Dabradian complexes in Scotland received their metamorphic characters during the Caledonian movements, and that they are formed of Torridonian (Sparagmite) and early Palæozoic formations, rather than of a pre-Cambrian series metamorphosed before Palæozoic times. However much this conclusion might simplify the stratigraphy of certain areas, it seems incompatible with the known unconformity of unmetamorphosed Ordovician beds on Dabradian schists and quartzites in western Ireland.

Oil Fields and the Gravity Balance.—The recent use of the Eötvös gravity balance by the oil companies in prospecting for new and exploring old oil fields has brought into prominence an extremely sensitive instrument devised nearly thirty years ago by Baron Eötvös, professor of physics at Budapest, and constructed in 1888 by Süss, then director of the mechanical training workshops of Budapest. The instrument and the measurements made by means of it were described in Hungarian periodicals in 1890 but were not generally known till 1896, when a short account appeared in the *Annalen der Physik*, vol. 59, p. 354. An instrument has now been acquired for the Science Museum at South Kensington, and a paper by Messrs. H. Shaw and E. Lancaster-Jones describing it and giving its theory and some account of tests made by means of it, appears in the April issue of the Proceedings of the Physical Society of London. The instrument consists of a fine fibre which supports a horizontal rod, to one end of which a small mass is directly attached, while from the other an equal mass is suspended by a second fine fibre. The instrument determines the difference of the values of gravity at the two masses, and according to Eötvös will detect a difference of 1×10^{-9} C.G.S. unit.

Magnetic Recording Drum for Electric Relays.—It is now becoming increasingly difficult to differentiate between telegraph, telephone, and radio engineers. The paper read by Dr. N. W. McLachlan to the Radio Section of the Institution of Electrical Engineers on April 11 illustrates this. It is entitled "The Application of a Revolving Magnetic Drum to Electric Relays, Siphon Recorders, and Radio Transmitting Keys," and it is of equal interest to every kind of communication engineer. When the drum is magnetised, part of it is pressed on fixed iron rings with considerable force, and this alters the speed. The author finds that the tangential pull thus obtained is many times greater than the product of pressure due to the product of the magnetic attraction and the coefficient of friction. The ratio of the experimental pull to the calculated pull may exceed 50. It is suggested that the operation of the device depends on some form of cohesive action brought into play by magnetism.

Upper Air Data in America.—Free-air winds at Lansing, Michigan, are dealt with by Mr. C. L. Ray, of the U.S. Weather Bureau, in the U.S. *Monthly Weather Review* for December 1922. Pilot-balloon observations have been carried out at this station daily since June 1919, flights having been made for more than two years at 7 A.M. and 3 P.M., except when impossible through bad weather. Latterly, observations have only been made at 3 P.M. For the three-year period, the results are given for the four seasons of the year for various altitudes from the surface to 6000 metres, and the percentage of the winds from various directions is shown. More than 50 per cent. of the surface winds have a south component and more than 56 per cent. have a west component. At 4000 and 6000 metres the preponderant direction lies between west and north-west. The variation of the winds with altitude for each season is given by tables and graphs. Surface velocities average about three metres per second. At 250 metres the velocities average two and a half times greater than at the surface. Above 1500 metres, winds are consistently west to north-west. Velocities are greater in the winter months, and at the 6000 metre elevation the average reaches 27·7 metres per second as compared with the summer mean of 12 metres per second at that level. In the upper levels the easterly winds do not reach the velocities attained by the westerly winds. Winds with a surface south component all show a clockwise movement with altitude and generally have a west-south-west direction at about 2000 metres. There is a more or less persistent north component to the highest levels. The highest velocity reached at Lansing was 83 metres per second from the north-west at an altitude of about 7000 metres on December 17, 1919.

Ice Patrol Service in North Atlantic.—The U.S. *Monthly Weather Review* for December 1922 contains an article by Lieut. E. H. Smith on "Some Meteorological Aspects of the Ice Patrol Work in the North Atlantic." The disaster to the s.s. *Titanic* on April 14, 1912, when what was then the largest ship afloat was sunk by striking an iceberg off the tail of the Great Bank of Newfoundland, resulted in an ice patrol being established with the object of preventing the recurrence of a similar loss. The patrol was of International origin, the management of the service being undertaken by the U.S. Government. It is now about ten years since the service has been in operation, and much information has been gathered as to the determination of the variable limiting lines of menacing ice, and efforts have been made to determine the causes of the variations as to seasonal and other differences. Glaciers on the west coast of Greenland are said to be the great source of icebergs which appear during March drifting south along the east side of the Great Bank, and during April, May, and June they constitute a menace to steamships. The summer winds in West Greenland, the birthplace of the bergs, have an immense influence on the number of bergs over the North Atlantic in the following season. Off-shore winds drive a great number of bergs westward into the southerly current, while on the other hand, on-shore winds tend to cause a poor ice year. It is said to take approximately five months for a berg passing Cape Dyer to appear south of the 45th parallel. If the dates of the bergs passing Cape Dyer were known, long-range forecasting of ice conditions in the North Atlantic would probably be possible.

The Total Eclipse of the Sun, September 21, 1922.

By Dr. WILLIAM J. S. LOCKYER.

SOME time ago an account was given in these columns (December 29, 1921, vol. 108, p. 570) of the probable expeditions which would go out, and the stations that would be occupied, for the observation of the total eclipse of the sun in September of last year. This programme was very nearly followed, excepting that Mr. Evershed's party from South India, instead of occupying one of the islands of the Maldive group, went to a station, Wallal, on the north-west coast of Australia, thus joining up with other expeditions located there.

The eclipse track, it may be remembered, passed over the Maldive Islands, Christmas Island, and Australia, leaving that continent on its eastern coast.

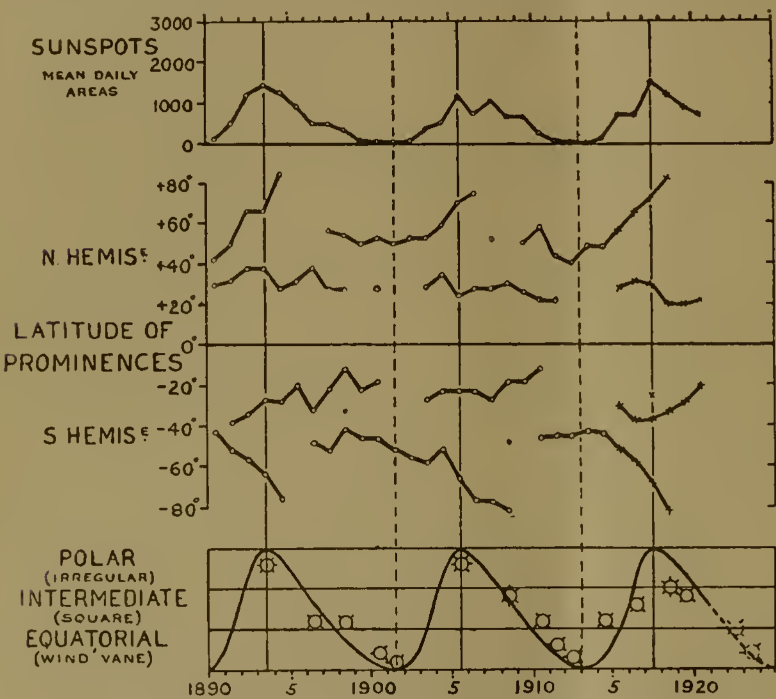


FIG. 1.—Comparison between prominence zones and forms of the corona. From Monthly Notices R.A.S., April 1922, vol. 82, No. 6, p. 324. By permission of the Royal Astronomical Society.

The Maldive Islands seem to have been unoccupied on this occasion, and the British and German expeditions to Christmas Island were so clouded out that no observations could be made. All the stations in Australia were favoured with fine weather, so a valuable series of records may be expected in due course.

The success of the Crocker Eclipse Expedition, which occupied Wallal, is shown by Dr. W. W. Campbell's account of the expedition which appears in the Publications of the Astronomical Society of the Pacific (vol. 35, p. 11). In the first instance, this expedition was organised on a modest scale, owing to the probable great difficulties of transport, etc., at this remote and somewhat inaccessible station in Australia. The generosity of the Australian Government in providing transport from Fremantle, and assistance both in personnel and material, altered the whole aspect of affairs. A much enlarged programme was, therefore, decided upon and was eventually carried out successfully.

The main programme was as follows:

A pair of cameras of 5 inches aperture and 15 feet focal length for application to the Einstein eclipse problem: the Shaeberle camera, aperture 5 inches and focal length 40 feet, for the photography of the solar corona: two cameras of 4-inch quadruplet lenses and 5 feet focus for the Einstein effect and other possible results of the sun's surroundings: several spectrographs for the photography of the coronal spectrum: and a camera of 5-inches aperture and 66 inches focal length for the photography of the form of the corona.

Dr. Campbell's account describes very fully the many and varied experiences of the trip to the station, the landing, the erection of the instruments, and the procedure to prevent the great amount of dust from affecting the mechanisms of the instruments. He pays great tribute to the valuable assistance rendered by Mr. H. A. Hunt, the Government meteorologist, charged with the general organisation of all the expeditions, and to the officers and men of the Royal Australian Navy detailed to accompany the expeditions to Wallal and provide for their needs at transfer points and at Wallal itself. The camp was quite up-to-date, receiving wireless time signals and a weekly aeroplane mail service.

Eclipse day proved ideal and the whole programme was followed successfully.

Owing to the irregularity of the moon's motion, the times of the eclipse were not exactly as forecasted. On this occasion the duration of the total phase for Wallal, assigned by the "Nautical Almanac," was five minutes nineteen seconds. At Wallal the beginning of totality came about sixteen seconds earlier than the predicted time, and the end occurred about twenty seconds earlier. Thus, mid-totality was eighteen seconds early and the whole total duration lasted five minutes fifteen and a half seconds.

The corona appeared visually small and relatively faint, and no large prominences were visible. It is stated that the form of the corona corresponded to that generally associated with sunspot minimum. This verifies the forecast I made in the article in this journal mentioned above, where it was stated that "the corona will most probably be of the 'wind-vane' type, in which the coronal streamers are restricted to the lower solar latitudes, while the regions of both poles will be conspicuous by the presence of the well-known polar rifts." The illustration which accompanies Dr. Campbell's paper indicates a typical form of "wind-vane" corona. (See Fig. 1.)

Dr. Campbell seems to have made supreme efforts to measure, on the spot, some of his plates for the Einstein effect, having previously succeeded in his arrangements for securing night comparison plates in the island of Tahiti. He wished at least to make a preliminary statement concerning the contribution of the expedition to the solution of the Einstein eclipse problem before he left Perth on his homeward journey. In his own words, " it was a severe disappointment to me, that the many delays, wholly beyond our control . . . prevented me from carrying out this plan." (The plates have since been measured, and, as was announced in *Nature* of April 21, p. 541, the results confirm Einstein's prediction.)

It was intended that the large-scale photographs of the corona obtained at Wallal, and by the Adelaide expedition at Cordillo Hills, should be compared for evidence of motion within the coronal streamers, during the interval of 35 minutes between the times of totality at the two stations. The very quiescent solar conditions at the time did not hold out very good prospects, as Dr. Campbell states, but probably the high quality of the negatives will on closer examination lead to positive results.

All the spectroscopic results of the corona indicated also a low activity of the sun, the coronal lines being very much fainter than those recorded in the eclipse of 1918.

The absence of prominences, the smallness of the corona and its faintness, all tended to make the eclipse a dark one, thus favouring ideal conditions for the Einstein plates to secure as many star images as possible.

There is little doubt that when the complete results of the Crocker Eclipse Expedition come to be published they will contain a valuable record of the work accomplished during the brief interval of five minutes fifteen and a half seconds.

Perhaps one may be permitted to take this opportunity of congratulating Dr. Campbell not only on the success of this expedition which he so ably led, but also on his election in January last to the presidency of the University of California. While this position will involve great responsibilities and absorb much of his time, he will still, fortunately, retain his directorship of the Lick Observatory and his residence on Mount Hamilton, and he will return there on all available occasions.

Alloys Resistant to Corrosion.

A GENERAL discussion on the subject of alloys presenting a high resistance to corrosion was held on April 13 at the University of Sheffield, the meeting being arranged jointly by the Faraday Society, the Sheffield Section of the Institute of Metals, and the Manchester Metallurgical Society. Sir Robert Robertson, president of the Faraday Society, occupied the chair. In his opening remarks the chairman referred to the economic loss involved in the corrosion of steel, and to the great step in advance represented by the introduction of stainless steel. In the chemical industry, the use of high-silicon irons had proved to be of great value. It was important to remember that the order of resistance of materials might be quite different towards different reagents, so that in nitration, for example, while iron and steel would resist the action of the concentrated acids, the same solutions after being deprived of their nitric acid would cause attack. The time was ripe for a general survey of the subject.

Prof. C. H. Desch, while noting that no theoretical paper was to be presented at the meeting, remarked that the study of corrosion had undergone a profound change in recent years. Formerly, the usual method of experiment was the determination of loss of weight of specimens under more or less arbitrary conditions, coupled sometimes with measurements of electrolytic potential. The first method gave purely empirical results, whilst the second was difficult to interpret, and the resistance of different metals and alloys often appeared to be quite incompatible with their positions in the electrochemical series. Gradually, investigators had become convinced that the physical character of the products of corrosion was a most important factor in the process. A metal which from its electrochemical position might be expected to corrode rapidly might in the early stages become coated with a protective film, after which the action was negligible. It was not only films of perceptible thickness that exerted such an influence. Recent work had shown the importance of films of oxygen and other substances, one atom or one molecule thick, to which no definite formula could be assigned, but they altered entirely the chemical character of the surface. It is still impossible to predict the composition of highly resistant alloys, and we have to be content with empirical trials, such as have led to the discovery of the alloys to be described. The theory of the subject is still imperfect, and he urged that more attention should be given to the fundamental work of Faraday, the neglect of whose teaching was responsible for much confusion of thought on the subject of corrosion.

Three main classes of alloys were dealt with by the readers of papers, namely, the stainless steels, the alloys of nickel with chromium, and the alloy known as Monel metal. Dr. W. H. Hatfield gave an account of the extensive series of laboratory tests made in the Brown-Firth Laboratory, in which many specimens were exposed to the action of simple and mixed electrolytes, the results being recorded numerically and by means of colour photography. The high resistance of the alloys of iron with chromium and varying amounts of carbon, known as stainless steels, was very evident from these experiments. This class of steels was described in detail by Mr. J. H. G. Monypenny. The greatest resistance to corrosion in these steels is obtained by quenching in such a way as to obtain a homogeneous martensite, while the attack by reagents is greatest when the steels are annealed so as to bring about the greatest separation of the carbide and the ferrite. This is in accordance with the known effects of galvanic action. Tempering at such a temperature that the internal stresses are relieved, but coalescence of the carbide is avoided, does not lessen the resistance. With a very low carbon content, nearly all the chromium is in solid solution, so that the steels are resistant even in the unhardened state, and this property has led to many new uses for the metal. The retarding effect of colloidal substances on corrosion is shown by the fact that while a properly hardened stainless steel is not attacked by vinegar or lemon juice, pure acetic or citric acid of the same concentration produces a marked attack. The same alloys are highly resistant to the action of air at high temperatures or of superheated steam.

It is for their resistance to these agents that the next series of alloys, those containing nickel and chromium as their principal constituents, are specially valued, and these alloys were described by Mr. J. F. Kayser. The technical alloys contain iron, and the useful compositions are limited to a comparatively small area on the ternary equilibrium diagram, although some experiments have been made with alloys outside that range. Copper is occasionally added when resistance to acids is required, but is detrimental when high temperatures are involved. Aluminium has a remarkable hardening effect, owing to the formation of the very hard and infusible compound NiAl. Wires for electric furnaces, case-hardening boxes, and reaction vessels for ammonia synthesis, are among the uses to which this group of alloys has been put. The corroding action of furnace gases containing sulphur compounds is due to the formation of nickel sulphide, which forms a fusible scale.

Mr. J. Arnott gave a short account of the behaviour of Monel metal, which is composed chiefly of nickel and copper, towards various reagents. This alloy is particularly resistant to sea water, to impure waters such as those of many mines, and to steam.

An important point was brought out by Mr. J. H. S. Dickenson, who remarked that for many technical purposes stainlessness as usually understood was not required, freedom from pitting and gross rusting being more important. For example, in submarine work it is not essential that parts should remain quite bright, but it is necessary that they should not become jammed by accumulations of rust. A piece of soft stainless steel, merely sand-blasted, had been exposed in the garden for eighteen months, and, although it had rapidly assumed a yellowish tarnish after the first rain, it had not lost weight, while a mild-steel sample had rusted badly. Mr. Macnaughten remarked that for some purposes a good electrical conductivity was required as well as resistance to corrosion, and that in such cases pure nickel had advantages even over Monel metal.

Some differences of opinion were manifested in regard to the chromium steels. The comparatively recent introduction of alloys so low in carbon as to be available for use without hardening, and in the cold-worked condition, has led to the use of the term "stainless iron" for such alloys, while other authorities prefer to regard the stainless steels as forming a continuous series of varying carbon content. Commercial considerations are involved, but it appears that for practical purposes there is a division, which occurs at the point where the carbon falls so low that the use of an expensive ferro-chrome becomes necessary in the manufacture. Scientifically, there is no break in the series.

Turning to another class of alloys, an interesting announcement was made by Mr. Harold Turner, who exhibited articles made of a new standard silver, free from copper, but containing the 92·5 per cent. of silver required in order to obtain the hall-mark. Although it is not claimed that such an alloy is resistant to acids, experiments had shown that the tarnishing caused by the atmosphere of a town was very greatly less than that of standard silver. Fuller particulars of this interesting alloy will be given at a later date. The working qualities prove to be excellent. No account was given of the alloys of the nickel silver group, some of which have been improved in respect of their resistance to corrosion, particularly by the introduction of tin in place of zinc; but Mr. F. Orme described some acid tests with several alloys of this class, showing little difference between them and the older alloys. It was, however, argued that these alloys are not intended for exposure to acids, and that only a higher resistance to atmospheric action is to be expected from them.

A valuable paper on the mechanism of so-called "dry corrosion" was read by Mr. U. R. Evans, of Cambridge, whose experiments included the examination of a number of metals and alloys when exposed to various gases, either saturated with moisture or in a relatively dry state, excluding the case of the complete absence of moisture. The action was regarded as electrolytic, the formation of a thin liquid film being an essential part of the process. The conductivity of such a film is an important factor. When the product formed is hygroscopic, so that the surface of the metal becomes visibly wet and the liquid may fall off in drops, as in the attack of zinc by hydrogen chloride, nickel by sulphur dioxide, and copper by ammonia, the corrosion is very rapid. Observation of the tarnish colours formed in the early stages of the corrosion seems to indicate that local anodic and cathodic areas are present at the beginning. The formation of temper colours by oxidation at higher temperatures, as in the case of iron above 220°, appears to be a different phenomenon. Dr. R. S. Hutton mentioned that this side of the subject was engaging the attention of the Non-Ferrous Metals Research Association, and that Mr. Vernon was conducting experiments for the Atmospheric Corrosion Committee in this direction. Mr. Vernon, in a written communication, questioned the necessity for the presence of water in such attack by gases, and offered an alternative explanation of the facts.

The discussion undoubtedly served a useful purpose in bringing together data as to the classes of alloys now available when a greater resistance than usual to corroding agents is required. Great progress has been made in this direction, to which the stainless steels and the alloys of the nichrome class, as well as the older silicon irons, bear witness. The new silver alloy is a further indication of the attention being given to the production of alloys which will suffer less by exposure to the atmosphere of towns. Unfortunately, a scientific theory of the phenomena is still lacking, the theory of corrosion, in spite of its very extensive literature, being lamentably imperfect. The process of trial and error, which is at present almost the only method for the discovery of resistant alloys, needs to be replaced by a systematic conception of the process, which will make it possible to predict, with some approach to accuracy, the behaviour of a new combination of metals towards a given environment. The Faraday Society has already performed useful services in regard to this matter, and it is to be hoped that when the next symposium is held it may be possible to review the subject in a less empirical manner.

University and Educational Intelligence.

ABERDEEN.—Sir Robert Horne, who delivered his address as Rector of the University on Thursday, April 26, dealt with the relation of the Universities to post-War problems, and with their increasing responsibility for "cultural" education in an age in which the pressure of business leaves less and less time for the cultivation of the arts. After the address, he announced that he intended to offer a prize of 25*l.* for an essay on "The Function of Universities in the Modern State."

CAMBRIDGE.—Prof. Nuttall and Sir William Pope have been appointed to represent the University at the ceremonies connected with the centenary of the birth of Pasteur to be held in Paris and Strasbourg during the present month.

In connexion with the jubilee celebration of the Local Lectures to be held in Cambridge in July, it is proposed to confer honorary degrees on Sir Michael Sadler, Prof. R. G. Moulton, and Messrs. Albert Mansbridge, G. P. Bailey, J. H. Fisher, and A. Cobham.

Sir Archibald Garrod, Regius professor of medicine, Oxford, will deliver the Linacre Lecture on May 5, the subject being "Glimpses of the Higher Medicine."

LONDON.—A research studentship for post-graduate work at the London School of Economics and Political Science will be awarded in July next. Its value will be 175*l.*, in addition to fees, and it will be tenable for two years. Application forms (which must be returned not later than May 31) can be obtained from the director of the School, Houghton Street, Aldwych, W.C.2.

Manchester.—Prof. de Sitter, of the University of Leyden, will deliver a lecture on "The Theory of Jupiter's Satellites" at the University on May 9, at 5.30 p.m. Visitors will be welcomed.

Oxford.—Sir Michael Sadler has been elected Master of University College, in succession to Dr. R. W. Macan, who retired from the office on April 1. Sir Michael Sadler was well known in Oxford from 1880 to 1895 as scholar of Trinity and steward and senior student of Christ Church. He was president of the Union in 1882, and from 1885 to 1895 he did valuable work as secretary to the then lately-established Oxford University Extension Scheme. He was appointed professor of the history and administration of education at the Victoria University of Manchester in 1903, and became Vice-Chancellor of the University of Leeds in 1911. Sir Michael Sadler is the leading authority upon education in Great Britain, and his return to Oxford is confidently expected to prove a source of increased strength to the educational efficiency of the University.

By the will of Dame Ella Mabel Farrar, the sum of 4000*l.* is bequeathed to such university or university college in the Transvaal as her executors shall select, to found a George Farrar agricultural scholarship for students of European birth.

H.R.H. Princess Mary, Viscountess Lascelles, has consented to present the prizes and certificates to the students of the London (Royal Free Hospital) School of Medicine for Women (University of London), Hunter Street, Brunswick Square, W.C.1, on Saturday, June 2. Scholarships to the total value of 1010*l.* will be awarded for the session beginning in October 1923. Full particulars and forms of entry can be obtained from the warden and secretary of the hospital.

On April 4, the Sterling Chemistry Laboratory of Yale University, the first building to be erected out of the funds provided by the bequest of John W. Sterling to the University, was formally opened, and Sir Joseph Thomson delivered an address on "The Unity of Physics and Chemistry." The date is interesting as being the centenary of the first lecture in chemistry delivered at Yale by the first professor of chemistry, Benjamin Silliman. The building has cost about 400,000*l.*, and according to *Science* of March 23, in which some details of its equipment are given, it is the finest material plant in the world for the teaching of chemistry and for research. There is a laboratory for industrial chemistry, which contains apparatus of factory size, and extends from the foundations of the building to the roof. The centre of the building is devoted to teaching laboratories, all on the same level, and separated from each other by light walls, which can readily be removed should it be necessary to enlarge any laboratory. The building also contains a large number of small private laboratories, two large lecture-halls, class-rooms, and a well-furnished library.

The foundation, recently announced, of six Henry P. Davison scholarships tenable by Oxford and Cambridge men for one year in Harvard, Yale, and Princeton Universities, may perhaps be regarded as significant of a movement in the United States in favour of endowments reciprocal to the Rhodes Scholarship Trust. Each of the Davison scholarships is worth 1500 dollars plus tuition fees, or about 375*l.* in all. According to an announcement by the Oxford selection committee, preference will be given, other things being equal, to undergraduates in their second year proposing to return, on the expiry of the term of tenure of the scholarship, to their own University for a further year of study. Selection will not be by examination. The selection committee will base their choice on a consideration of character, scholarship, and of general fitness to represent the University. It is understood that the scheme is, in its present form, experimental. Compared with the 96 Rhodes scholarships tenable in Oxford by Americans, the number of American university and college scholarships for British students is rather small. A list published in the "Universities Yearbook" gives: the Rose Sidgwick Memorial, 1000 dollars; Choate Memorial (Harvard), 1850 dollars; Bryn Mawr, three of 720 dollars each; Union Theological Seminary, New York, 1200 dollars; Jane Eliza Procter (Princeton), two of 2000 dollars each; and Auchinloss and Dawson (Yale), 2000 dollars. The very magnitude of the Rhodes Scholarship Trust has perhaps hitherto tended to discourage reciprocity.

Education Week in America, December 3-9, was marked by proclamations by the president of the United States and by governors of 42 States, by hundreds of thousands of addresses, sermons, and speeches, by special editions of or editorial support in half of the newspapers of the country and by articles in practically all the others, by special exhibitions in practically all the motion-picture theatres, and by messages from numerous broadcasting stations. What is the justification for such a raging and tearing campaign? The United States Government Commissioner of Education answers this question by saying that no step forward in education can be made except as the result and with the approval of public sentiment, and it is therefore of fundamental importance to arouse the interest of the public generally, and not merely of the educator and educated man, in the needs of education. The Bureau of Education itself made use in Education Week of the Government naval aircraft broadcasting station, and followed this up by establishing a regular service of broadcast messages. The "radio talks" are given on Monday and Thursday evenings, and deal with such subjects as consolidation of rural schools, health work in schools, etc.

The report for 1922 of the Carnegie United Kingdom Trust gives particulars of grants amounting to 106,669*l.*, distributed as follows: Libraries 68,303*l.*, music and the drama 17,320*l.*, physical welfare 10,300*l.*, hostels 6452*l.*, miscellaneous 4294*l.* Of the grants for libraries 36,000*l.* went to rural circulating, 24,000*l.* to urban, and 5000*l.* to special libraries (central libraries for students, Co-operative Library of Dublin, Royal Aeronautical Society, College of Nursing, and Merchant Seamen's), while 1500*l.* was given to the School of Librarianship and 1600*l.* to the "Subject Index to Periodicals." The trustees aim at "providing the initial expenditure necessary for the efficient inauguration" of projects likely to have permanent national value, and especially new projects of a pioneer character, rather than at maintaining indefinitely enterprises which give no promise of becoming self-supporting. Their operations derive from this principle a certain liveliness not commonly associated with the administration of property in mortmain. In connexion with the rural libraries scheme the report comments on the disadvantages of the system under which in England and Wales the Education Committee is only a department of the County Council instead of being an autonomous authority as in Scotland. Among other important benefactions are: a guarantee of 1000*l.* in connexion with the publication of a "World List of Scientific Periodicals," showing libraries in Great Britain where they are on file, and a grant for the National Institute of Industrial Psychology.

Societies and Academies.

London.

Royal Society, April 26.—W. A. Bone, D. M. Newitt, and D. T. A. Townend: Gaseous combustion at high pressures. Pt. III.—The energy-absorbing function and activation of nitrogen in the combustion of carbon monoxide. Nitrogen can no longer be regarded as an inert gas in the combustion of carbon monoxide, because when present as a diluent in a mixture of two volumes of carbon monoxide and one volume of oxygen undergoing combustion in a closed vessel under high pressure, it exerts an energy-absorbing influence which (*a*) retards attainment of maximum pressure, and (*b*) diminishes maximum temperature attained in explosion. The effects are much greater than those due to any other diatomic diluent. The energy so absorbed by nitrogen during the combustion period is slowly liberated as the system cools down after attainment of maximum temperature, and consequently the rate of cooling is greatly retarded. These effects are very marked in the case of a carbon monoxide-air mixture ($2CO + O_2 + 4N_2$). In consequence of such energy-absorption, nitrogen becomes chemically "activated" in such explosions, and while in this condition will combine with oxygen, forming oxides of nitrogen. If no nitrogen be present in a carbon monoxide-oxygen (2 : 1) mixture, carbon monoxide burns in oxygen at high pressures almost as rapidly as does hydrogen. There is no correspondingly large (if any) energy-absorbing effect (other than purely "diluent") when nitrogen is present in hydrogen and oxygen mixtures similarly undergoing combustion, and there is no evidence of nitrogen being then activated. Two or three per cent. of hydrogen in a carbon monoxide-air mixture undergoing combustion prevents any material activation of the nitrogen. It appears that the influence of nitrogen in the carbon monoxide-oxygen explosions is due to its ability to absorb the particular quality of radiation emitted; such radiation is known to be of a different wave-length from that emitted during the flame-combustion of hydrogen. In other words, there seems to be some constitutional correspondence between carbon monoxide and nitrogen molecules, whereby the vibrational energy (radiation) emitted when one reacts with oxygen is of a quality readily absorbed by the other, the two acting in resonance.—R. A. Watson Watt and E. V. Appleton: On the nature of atmospherics. Observations with a cathode ray oscillograph, on the temporal variations of the electric force occurring in radio telegraphic atmospherics are described. The principal constants of six hundred typical atmospherics are examined. A bare majority are quasi-periodic, consisting normally of one complete oscillation, of duration 2000 micro seconds, the mean change of field being 0·128 volts per metre, with no marked unbalanced transport of electricity on the whole group. The second group consists of aperiodic impulses, of duration generally about 1250 micro seconds, but frequently reaching 0·025 of a second, the mean change of field being 0·125 volts per metre, with a seven to one numerical predominance of discharges tending to carry negative electricity to earth in the receiving antenna.—I. Masson and L. G. F. Dolley: The pressures of gaseous mixtures. Measurements have been made at 25° of the compressibilities up to 125 atm. of ethylene, argon, oxygen, and a series of binary mixtures of these. The volume of a compressed mixture usually exceeds the sum of the separate volumes of its two components, the excess depending on the molecular ratio of the two gases chosen and upon the pressure. Thus with an equimolecular mixture of argon and ethylene at 80 atm. the volume is greater than the additive value by 24 per cent. At a given pressure there is an "optimum" composition, and with a given composition there is an optimum pressure. Oxygen-ethylene mixtures behave quantitatively in the same way as argon-ethylene; oxygen and argon when mixed show a negligible volume increase, and are individually equally compressible. The pressure of a mixture at high densities exceeds the sum of those measured for the separate constituents; at moderate densities it is definitely less. The former occurrence is due to the actual space filled by the molecules; the latter is due to a mutual cohesion between each.—T. R. Merton and R. C. Johnson: On spectra associated with carbon. The spectral changes due to the admixture of helium to vacuum tubes containing carbon compounds, and the conditions for isolating the band spectra associated with carbon, have been investigated. The "high pressure CO" bands can be isolated almost completely; the "comet-tail" bands are found in vacuum tubes containing helium and carbon monoxide. In the presence of helium the distribution of intensity in the comet-tail bands differs markedly from that observed by Fowler in tubes containing carbon monoxide at very low pressures. By the admixture of hydrogen the comet-tail bands are replaced by a system of triplet bands, and the wave-lengths of the heads of these bands fall into two distinct band series. In helium containing a small quantity of carbon monoxide a new line-spectrum has been observed under suitable conditions of excitation, which is attributed to carbon.—W. R. Bousfield and C. Elspeth Bousfield: Vapour pressure and density of sodium chloride solutions. A standard set of vapour pressure determinations at 18° C. for aqueous solutions of common salt at all concentrations was required. Water and the solution were introduced into the legs of a V tube surmounting a barometric column of mercury, excluding all air. This necessitated the boiling of the solutions so that they became of unknown concentration. The vapour pressure observations were therefore correlated to the densities of the solutions and the latter with a complete set of density observations at 18° C. made on solutions of known concentration accurate to ± 2 in the fifth place of decimals.—F. A. Lindemann and G. M. B. Dobson: A note on the temperature of the air at great heights. The relatively high temperature of the atmosphere above 60 km. appears to be due to absorption of an appreciable amount of direct solar radiation. Thus there should be a large variation in temperature at these great heights. Some evidence of such variation has been found.—G. H. Hardy and J. E. Littlewood: On Lindelöf's hypothesis concerning the Riemann zeta-function.

Physical Society, March 23.—Dr. A. Russell in the chair.—W. J. H. Moll: (1) A new moving-coil galvanometer of rapid indication. The galvanometer is designed to secure rapid indication and steadiness of reading without unduly sacrificing the sensibility. The coil is long and narrow, and therefore of small moment of inertia; the mirror is supported by the wires forming the coil, between which it is slipped, and the coil is supported between an upper and a lower vertical wire, as distinct from strips, made of silicium bronze and put in tension. (2) A thermopile for measuring radiation. The thermopile is designed to be quick-reading and free from zero-errors, as well as sensitive. The cold junctions are in contact with metal masses, and in order that the hot junctions may have small heat capacity, the bi-metallic strips composing the thermopile are made of plates of constantan and manganin silver-soldered along an edge, rolled in a direction parallel to the edge into thin foil, and then cut into strips perpendicular to the edge.—C. W. **Hume**: A note on aberration and the Döppler effect as treated in the theory of relativity. Aberration has been explained as due to the compounding of the velocity of light with the velocity of the earth relative to the ether; hence it appears to conflict with the principle of relativity. Simple methods are given of treating this problem consistently with the restricted principle, and of finding the Döppler effect. The result differs from the non-relativity result by terms of the second and higher orders in v/c.—C. R. **Darling** and C. W. **Stopford**: Experiments on the production of electromotive forces by heating junctions of single metals. When a circuit is closed through a junction of a cold metal with a hot piece of the same metal, large electromotive forces are often noticed; *e.g.* a bare copper wire connected to the terminals of a galvanometer was cut at the middle, one of the cut ends heated and brought into contact with the cold end, and a large deflexion was obtained. Electromotive forces up to 0·25 volt may thus be produced.—R. H. **Humphry**: The double refraction due to motion of a vanadium pentoxide sol, and some applications. In linear flow the liquid behaves in the same way as a plate of uniaxial crystal cut parallel to the axis and placed with axis parallel to the direction of flow. The field between crossed nicols lights up near an obstacle interposed in a stream of the liquid. Similar effects due to efflux of the sol from a jet, to the convective stream from an electrically-heated wire, etc., were also described.

Optical Society, April 12.—Prof. A. Barr, president, in the chair.—F. **Twyman**: The Hilger microscope interferometer. The instrument is used for measuring the aberrations of microscope objectives. A collimated beam of monochromatic light is separated into two beams at the transmissively silvered surface of a plate of plane parallel glass. The transmitted beam passes through the lens under test, and is reflected back from the surface of a convex mirror, which coincides nearly with the approximately spherical wave front of the light as it converges after passage through the lens. The second beam is reflected back along its own path by a mirror so that the two beams recombine at the silvered surface of the plane parallel plate. Portions of each beam then pass on together through a lens to the observer, who sees an interference pattern apparently located on the surface of the lens under test, which is a contour map, to a scale of half wave-lengths of the light used, of the aberrations of wave-surface caused in a plane wave.—A. **Whitwell**: On the form of the wave-surface of refraction. A series of wave-surfaces is drawn for each of a number of refracting surfaces or lenses. Each series consists of the following forms, which always follow each other in the same order. (1) Saucer type; convex to the incident light when the refracted pencil is converging, and concave when the pencil is diverging. (2) Saucer with inturned edges; like (1), but the edges of the wave-surface which have passed through the primary focus are concave towards the incident light when the refracted pencil is converging. (3) Closed surface type; the wave-surface is completely closed like a cone with a dished bottom, the axis of the cone being coincident with the optic axis. (4) Goblet type; somewhat like a champagne glass set sideways, the bowl being towards the incident light and the base towards the secondary focus. (5) Basin type; the base of the goblet has disappeared and just beyond the focus the surface is like a basin concave towards the incident light. The diffraction spectra are found in the neighbourhood of the edges of the saucers, of the apex of the closed surface type, and of the rims of the goblet and basin type. Interference patterns occur in the region bounded by the caustic and by the extreme marginal rays. By drawing wave-surfaces half a wave-length apart lines of maximum and minimum intensity are found which are the sections of surfaces of revolution on which the intensity is a maximum or minimum. Sections of these surfaces by a plane at right angles to the axis show interference rings. The goblet type of wave-surface always occurs between the focus for marginal rays and that for paraxial rays, and may be called the characteristic of the focus.

Linnean Society, April 19.—Dr. A. Smith Woodward, president, in the chair.—A. B. **Rendle**: The structure of the fruit of the mare's-tail (*Hippuris vulgaris* Linn.). The fruit is a drupe, the upper portion of which around the persistent base of the style, with the seedcoat, is developed in the form of a stopper which is easily withdrawn on soaking the ripe fruit. The embryo ultimately fills the seed, and has the large radicle and hypocotyl so often found in water plants. The radicle is placed directly beneath the stopper which provides a place of exit on germination.—B. Daydon **Jackson**: History of botanic illustration during four centuries (Colour). In the early years of printing, copper-plate engraving was employed in providing outlines for hand-colouring and was in use until the last century, when it was ousted by lithography. In Redouté's method of semi-stipple for coloured prints each colour was separately applied to the plate and cleaned off, before finally heating the plate and pulling the print. Chromo-lithography has greater permanence, if lasting colours are employed, than hand-coloured plates. In the three-colour process three (or four) half-tone blocks are prepared, each to print its own colour, to give a complete colour scheme. The weakness of the process lay in this, that it almost demanded a paper coated with baryta or china-clay, which could not be guaranteed as permanent: in addition was the temptation to use inks, made from aniline dyes, which were fugitive.

Cape Town.

Royal Society of South Africa, March 21.—Dr. A. Ogg, president, in the chair.—B. T. **Schönland**: On the passage of cathode rays through matter. The absorption, reflexion, and secondary emission involved in the passage of fast cathode rays through thin foils of various metals, and their variation with the velocity of the rays, were examined. Accurate measurements were possible up to 0·4 of the velocity of light. The results show that Lenard's Law is only an approximation. The existence of a "range" for these particles appears to be established, two independent methods of measuring it agreeing very satisfactorily. The values obtained are in agreement with the theory of absorption due to Bohr.—T. **Stewart**: Holtzhuisbaaken Spring, Cradock. The spring is a typical Karroo spring. Measurements of the flow have been taken over a period of 38 years. The rainfall of a particular season is found to be reflected in the flow, but is not necessarily proportional to it; regard must be had as well to the rainfalls of previous seasons and the "tail" of the flow produced by them.—Gertrud **Theiler**: Two new species of nematodes from the zebra. *Cylindro-*

pharynx intermedia inhabits the pelvic flexure and dorsal colon of the host, of which it is one of the commonest parasites, and *Habronema zebræ* occurs in fairly large numbers in the stomach.—Sir Thomas Muir: Note on Zeipel's condensation-theorem and related results. Both Zeipel's papers on determinants are now over fifty years old and have been somewhat neglected. One or two of the basic results of Zeipel's first paper are discussed and a number of deductions that cluster somewhat picturesquely round them.

Official Publications Received.

Mysore Agricultural Calendar, 1923. Pp. iii+54. (Bangalore: Government Press.) 1 anna.

The Journal of the Royal Agricultural Society of England. Vol. 83. Pp. 8+260+cxlviii+24. (London: J. Murray.) 15s.

Thirty-fourth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1912-13. (With accompanying paper, "A Prehistoric Island Culture Area of America," by J. Walter Fewkes.) Pp. 281+120 plates. (Washington: Government Printing Office.)

Report of the Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii for the Biennial Period ended December 31, 1922. Pp. vi+102+16 plates. (Honolulu, Hawaii.)

Diary of Societies.

SATURDAY, MAY 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. L. L. B. Williams: The Physical and Physiological Foundations of Character (2).

MONDAY, MAY 7.

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

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—P. Mauclère: Pneumatic Handling of Petrol and other Inflammable Liquids.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—L. J. Russell: Some Points in the Philosophy of Leibniz.

ROYAL SOCIETY OF ARTS, at 8.—S. S. Cook: The Development of the Steam Turbine (2). (Howard Lecture.)

SURVEYORS' INSTITUTION, at 8.—C. H. Bedells: Some Functions of a Surveyor under the Settled Land Acts 1882-1890, and Part II. of the Law of Property Act, 1922.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—F. Kingdon Ward: The Tibetan Border; Yangtse to Irrawaddy.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section) (Annual General Meeting), at 8.30.—Lt.-Col. A. E. Hamerton: The Establishment of an Anti-rabic Institute in the Tropics.

TUESDAY, MAY 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. C. Seward: The Ice and Flowers of Greenland.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—W. A. Guthrie: Heavy Grade Egyptian Crude Petroleum.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Exhibition of Photographs of Big Game from Choma, Northern Rhodesia.—Miss L. E. Cheesman: (1) Exhibition of Living Specimens of *Peripatus* from Trinidad. (2) Exhibition of Section of a Nest of the Stingless Bee from Australia.—H. Burrell: Note on a Hibernating Female Specimen of the Marsupial *Acrobates pygmæus*.—F. Martin Duncan: The Microscopic Structure of Mammalian Hairs.—I. The Hairs of the Primates.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 5.30.—Annual General Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—R. R. Dobson: Mental Tests.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—E. Kilburn Scott: The Pioneer Work of Le Prince in Moving Pictures.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—R. Paulson: Fungi and Birch Trees.

WEDNESDAY, MAY 9.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. G. Keynes: Chronic Mastitis.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-section of Proctology) (Annual General Meeting), at 5.30.—Sir Humphry Rolleston, Sir Thomas Horder, W. E. Miles, P. Lockhart-Mummery, Prof. L. S. Dudgeon, Dr. W. E. Carnegie Dickson, and Dr. A. F. Hurst: Discussion on Ulcerative Colitis.

INSTITUTE OF PHYSICS (at Institution of Electrical Engineers), at 5.30.—Dr. J. W. Mellor: The Application of Physics to the Ceramic Industry.

INSTITUTION OF AUTOMOBILE ENGINEERS, at 7.30.—Col. R. E. Crompton: The Effect of Motors on Roads.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. A. Bone: Recent Developments in Surface Combustion, with Special Reference to Recent Developments in Radiophragm Heating.

THURSDAY, MAY 10.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10 a.m.—Report.—Presentation of Bessemer Medal to Dr. W. H. Maw.—E. R. Sutcliffe and E. C. Evans: The Reactivity of Coke as a Factor in the Fuel Economy of the Blast Furnace.—F. Clements: British Steel Works Gas Producer Practice.—J. E. Fletcher: Some Characteristics of Moulding Sands and their Graphical Representation.—J. H. Whiteley and A. Braithwaite: Some Observations on the Effect of Small Quantities of Tin in Steel.—L. Northcott: Note on Temper Carbon.—J. W. Landon: Change of Density of Iron due to Overstrain.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 2.30.—Prof. H. C. H. Carpenter: The Production of Single Metallic Crystals and some of their Properties.—Prof. J. O. Arnold: The Co-relation of the Chemical Constitutions of "True Steels" to their Micrographic Structures.—D. Hanson and J. R. Freeman: The Constitution of the Alloys of Iron and Steel.—T. F. Russell: The Potential Energy of Cold Worked Steel.—F. C. Thompson and A. Goffey: The Changes in Iron and Steel below 400° C.—L. E. Benson and F. C. Thompson: Some Experiments on Grain-growth in Iron and Steel.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. T. MacGregor-Morris: Modern Electric Lamps (3): Glowing Gases (Neon Lamps).

ROYAL SOCIETY, at 4.30.—Prof. A. Fowler: The Series Spectrum of Trebly-ionised Silicon (Si IV).—Sir Robert Robertson and W. E. Garner: Calorimetry of High Explosives.—Dr. H. S. Hele-Shaw: Stream Line Filter.—Dr. F. W. Aston: A Critical Search for a Heavier Constituent of the Atmosphere by means of the Mass-Spectrograph.—Prof. H. E. Armstrong: Electrolytic Conduction; sequel to an attempt (1886) to apply a Theory of Residual Affinity.—Prof. H. E. Armstrong: The Origin of Osmotic Effects. IV. Hydrodynamic Change in Aqueous Solutions.—Prof. R. W. Wood and A. Ellett: The Influence of Magnetic Fields on the Polarisation of Resonance Radiation.—W. G. Palmer: A Study of the Oxidation of Copper and the Reduction of Copper Oxide by a new Method.—E. A. Fisher: Some Moisture Relations of Colloids. II. Further Observations on the Evaporation of Water from Clay and Wool.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 5.—Annual General Meeting, to be followed by a Clinical Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. J. A. Fleming: Problems in Telephony, Solved and Unsolved (Fourteenth Kelvin Lecture).

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. J. W. French: Stereoscopy restated.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. W. H. Perkin: Adolph von Baeyer Memorial Lecture.

FRIDAY, MAY 11.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10.—Announcement of award of the Andrew Carnegie Research Scholarship.—C. A. Ablett: Economic Principles governing the Use of Electrical Power in Iron and Steel Works.—T. P. Colclough: The Constitution of Basic Slags—its Relation to Furnace Reactions.—Prof. C. H. Desch and A. T. Roberts: Some Properties of Steels containing Globular Cementite.—K. Honda and T. Murakami: The Structural Constitution of Iron-Carbon-Silicon Alloys.—T. Matsushita: Some Investigations on the Quenching of Carbon Steels.—E. J. L. Holman: Note on a Value for the Surface Tension of Iron Sulphide.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 2.30.—C. A. Edwards and C. R. Austin: A Contribution to the Study of Hardness.—F. C. Langenberg: An Investigation of the Behaviour of Certain Steels under Impact at Different Temperatures.—J. Stead: The Cold Working of Steel with Reference to the Tensile Test.—J. J. A. Jones: The Acl Range in Alloy Steels.—C. R. Austin: Some Mechanical Properties of a Series of Chromium Steels.—H. O'Neill: Variation of Brinell Hardness Number with Testing Load.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—J. H. Jeans: The Present Position of the Radiation Problem (Eighth Guthrie Lecture).

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5.30.—Prof. C. W. Valentine: The Place of Imagery in the Appreciation of Poetry.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. F. C. Cooper: The Theory of Resistance to the Flow of Gases and Fluids in Pipes (Durham Bursar's Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. A. Bone: Gaseous Combustion at High Pressures.

PUBLIC LECTURES.

MONDAY, MAY 7.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.15.—Prof. W. de Sitter: Problems of Fundamental Astronomy.

TUESDAY, MAY 8.

UNIVERSITY COLLEGE, at 5.—Prof. H. R. Kruyt: The Electric Charge of Colloids.—At 5.30.—J. H. Helweg: Danish Scenery.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: Blaise Pascal: Tercentenary of his Birth, June 19, 1923 (1) (succeeding Lectures on May 15, 22, and 29).

BIRKBECK COLLEGE, at 6.—Sir Richard Gregory: The Worth of Science.

WEDNESDAY, MAY 9.

UNIVERSITY COLLEGE, at 5.15.—Sir Thomas H. Holland: Phases of Indian Geology (succeeding Lectures on May 23 and 30).

THURSDAY, MAY 10.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 4.30.—Dr. H. H. Dale: The Physiology of Insulin.

KING'S COLLEGE, at 5.30.—Principal L. P. Jacks: Reality in Religion and Education (Hibbert Lecture).

FRIDAY, MAY 11.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. P. Giles: The Aryans (succeeding Lectures on May 25 and June 8.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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CONTENTS.

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The Zoological Record.

THE decision of the Zoological Society's council to discontinue the publication of the "Zoological Record" on the grounds of expense suggests somewhat opposing thoughts. It is generally admitted, or even strongly urged, by most workers in every branch of science that some guide to the ever-increasing flood of literature is a necessity. If this was true in 1865, when the "Zoological Record" was started, it is no less true to-day. The need, in fact, must have increased in at least the same direct ratio as the number of publications. Yet in zoology, as in geology and other sciences, these guides, records, and indexes have had a perpetual and severe struggle for life, in the course of which many have from time to time succumbed, been revived under another form, and too often again collapsed.

The "Zoological Record" itself was begun in 1865 as a publication by Van Voorst, under the editorship of Dr. Albert Günther, with a distinguished staff of recorders. The publisher paid for the printing, but the manuscript, we believe, was compiled for nothing. Mr. Van Voorst soon found the loss too great, and, though he continued as publisher, an association was founded in 1871 to guarantee the expenses. This carried on till 1887, when the Record was saved from extinction by the Zoological Society, which generously shouldered the burden and bore it unaided until the establishment of the International Catalogue of Scientific Literature. The question then arose whether the record of zoology should merely become one part in that vast scheme. Fortunately the secretary of the Zoological Society was far-sighted enough to preserve the continuity and title of the Record and the control of the Society, by inducing his council to contribute largely to the expense and to maintain its Record Committee. Consequently, when the International Catalogue failed, and when the Royal Society declined to undertake the huge expenditure on what had virtually become its sole responsibility, then zoologists still found their Record appearing—retarded and weakened, but in being and ready to resume its old strength and value whenever they themselves would provide the necessary sustenance. Unfortunately, the increased costs of production have coincided with the loss of a number of subscribers owing to the effects of war and its sequelæ. The secretary of the Zoological Society has over and over again sought in various directions to supply this loss, but has not met with any cheering response. All these facts must be remembered before we venture to blame the Society for its present decision.

When, now, we see the "Zoological Record" threatened with the fate that has overtaken so many similar publications, it is time to inquire more closely into the causes. For one thing, we note that the editorial and recording work is no longer done for the love of the science. For many years, indeed, the editor and recorders have been paid, but of late the appropriation for this purpose has grown enormously. Times, no doubt, have suffered an economic change; there are fewer people with money and leisure enabling them to work for nothing. But more of our younger workers should be inspired by the thought of service to their science, and should realise the experience and knowledge they themselves could gain by compiling a good Record. The work, too, is lightened for them. The International Catalogue introduced the system of furnishing the recorders with slips ready written, and to a certain extent this system is continued by the payment of searchers. We ought, therefore, to be getting an even better Record than we are, and we were hoping that it would have been possible before long to restore some details eliminated by the need for economy. Clearly, the greater the value the better is the prospect of selling.

So we pass from the producers to the purchasers. Here there are two points to be made. First, every worker should consider seriously whether he is prepared to devote a large proportion of his time to ransacking literature, at least that part of it which alone is accessible to him, or in default to work in a state of haphazard half-knowledge, or whether he is prepared to save his time by paying some one else a trifling wage (about a shilling a week) to furnish him with a complete analytical index to the yearly harvest of his science. Put thus, can he remain in doubt? If he is not stirred by conscience to pay himself, he can at least insist that the institution for which he works shall find the money and provide the book. But there is a second point. Admitting that there exist a few workers so exceedingly distinguished that they are furnished with complimentary copies of every paper on their subject that appears from China to Peru, this can scarcely affect the fact that most workers in pure or applied zoology are not in that easy position. The trouble with them is that, for the most part, they have never heard of the Record. We believe this statement to be no exaggeration, and we would urge the advisability of some real advertising. The occasion is favourable, for such competitors as there have been are nearly all now out of the running. One good way would be to induce university professors to instruct their pupils in the craft of bibliographic research.

What, then, is the conclusion? For thirty-six years the Zoological Society has earned the thanks and praise of zoologists for its support of this indispensable aid. But zoologists at large must now do their share if they wish this support to continue. On their side, as well as on that of the recorders, there must be a little more enthusiasm and self-sacrifice. The vessel is stranded, but with good will from all hands she can be kept afloat till the high tide returns. If the workers will give some real earnest of this good will, we cannot believe that the Society which has so long served as pilot will leave her to be broken up.

Hygiene of the Great War.

History of the Great War: Based on Official Documents. Medical Services: Hygiene of the War. Edited by Major-Gen. Sir W. G. Macpherson, Colonel Sir W. H. Horrocks, and Major-Gen. W. W. O. Beveridge. Vol. 1, pp. xii + 400. Vol. 2, pp. vi + 506. (London: H.M. Stationery Office. 1923.) 21*s*. net each.

THE two volumes dealing with that part of the Medical Services of the War which was concerned with preventive medicine possess great historical interest and high current value; they form an admirable example of the excellent results achievable when science is applied to practical life.

The first volume deals with general administrative problems, and comprises chapters on sanitary administration in the field, on the schools of sanitation and instruction organised to secure sanitary practice, on methods of water purification and of disposal of waste products in different countries, and on the housing and the clothing of the soldier. The second volume is concerned with food rations, with the physical test stations, the base hygienic laboratories, and with prisoners of war; these chapters being followed by special discussions on the prevention of malaria, of trench foot, of bilharziasis, of trachoma, of smallpox, and of plague, which present more vividly than the other chapters the successful conquest of science over disease.

The prevention of typhoid and paratyphoid, of typhus and of trench fever, are not included in the discussions in these volumes; but as the prevention and cure of pediculosis forms the essential element in the elimination of the last two of these diseases, the very full discussion given to the methods of disinfestation found most useful in the War fulfils the main need from the point of view of health, the clinical accounts of these diseases being given in other volumes of the history of the War. Similar remarks apply as regards scurvy and beri-beri, but on p. 73 of the second volume is an interesting statement as to the means taken to supply British and Indian troops with fresh fruit juice in Mesopotamia. In the prevention of beri-beri the addition of oatmeal and dhall to the British ration, the addition of marmite, and later, the issue of bread containing 25 per cent. of atta, were found valuable. After May 1917, following the report of Misses Chick and Hume, germinated dhall was used in outlying districts, when fresh vegetables or fruit could not be obtained.

A remarkable feature of medicine in the War was the stimulus given by war to scientific investigation. The instance already given is in point; and many other investigations were successfully carried out under the compulsion of urgent necessity. The pathogenesis of trench fever unfortunately was only fully revealed towards the end of the War; otherwise disinfestation of soldiers would have formed an even larger part of army sanitary work than it did. For details of a valuable investigation of energy expenditure in relation to food by Dr. E. P. Cathcart, chap. iv. in the second volume should be consulted. In the prevention of trench foot, success was at once attained so soon as compliance was secured with the army routine order that every man should remove his boots at least once in twenty-four hours, drying and rubbing his feet and putting on dry socks in place of those discarded.

In view of the large part borne by flies in conveying infection in the South African War, the prevention of flies in all divisions of the Army was vigorously promoted in the Great War, and the chapter devoted to this is a useful summary of the subject. The chapter on the prevention of infestation by lice, which is written by Sir W. H. Horrocks, is a masterly presentation of this important subject, including the biological facts, on knowledge of which efficient preventive measures must be based. The sixty-one pages devoted to this subject do no more than represent its relative importance in military hygiene, when we recall that Colonel Horrocks estimates that in the War 50 per cent. of the admissions to hospital from troops in the field armies were attributable to lack of personal cleanliness and to vermin. The great sanitary lesson of the South African War was that of fly prevention and satisfactory conservancy methods; the great sanitary lesson of the Great War has been that probably one-half of the disablement of our armies in the field is due to pediculosis and scabies.

Scabies was made the subject of accurate investigation at Cambridge, civilians volunteering for this purpose. These investigations showed that the infection of scabies could be conveyed by sleeping in beds previously occupied by heavily infested soldiers or by wearing their clothing. Perhaps the least satisfactory disease prevailing among soldiers, from the point of view of control, was cerebro-spinal fever; and although very specialised efforts were made to prevent its dissemination, it may be doubted whether these were successful, apart from the diminished prevalence which was secured when barracks became less crowded and an approximation towards open-air conditions became possible. There does not appear to be any justification for the belief that the segregation of contacts with cases of the disease or the chemical spraying of the throats of contacts, which was practised on a large scale, greatly influenced the course of events.

There are but few statistics of disease in these two volumes; but it is significant that whereas in the South African War, with an aggregate personnel of 530,000, 8000 men died of typhoid fever, only 266 deaths from this disease occurred in the Great War in the Western Front among British and Dominion troops, with an average strength of 1¼ millions and an aggregate of three or four times that number. The relative share of prophylactic vaccines, of purification of water, and of the sanitary disposal of waste-products in securing the remarkably low incidence of typhoid and of dysentery in the War is not discussed in these volumes; but we hope that in some other volume of the history of the War it will be possible to give details of any experiences in which one or other of these factors of prevention was absent, with the view of assessing their relative value in actual experience.

Attention is directed in Sir W. G. Macpherson's preface to the fallacious illogicality of estimating the healthiness or otherwise of troops by the ratio of deaths from disease to deaths from wounds. This ratio is evidently one between two variables: in particular the number and extent of the battles may vary. As a permissible limit of inefficiency due to sickness in an army in the field, 0·3 per cent. of strength had been accepted as a permissible limit; and this empirical standard was found in experience to be most useful in directing attention to the need for special inquiry in any unit.

The details of sanitary organisation given in vol. 1 are of importance to all practical workers, and this volume will for years form a valuable source of information. The success of the sanitary work of the Army in circumstances involving a manifold multiplication of existent machinery is one of the most striking features of the War. Some of the factors rendering this rapid addition to sanitary staffs practicable are not stated in these volumes; but it is noteworthy that the health of the troops sent abroad depended primarily on the condition of the rapidly improvised camps which were scattered throughout this country; and that the sanitary safety of these camps depended in large measure on the sanitary provisions in the districts in which they were placed, and on the active co-operation between local and central sanitary authorities and the Army authorities. The records of the Local Government Board and of local authorities show that their assistance was given whole-heartedly, and that the soldiers had the full advantage of the high general standard of civil sanitary administration in this country. Furthermore, the Army Sanitary Officers were recruited from the ranks of medical officers of health. To these facts, to the excellent Army medical organisation, to the Army schools of instruction in hygiene, and to the fact that the sanitary lessons of the South African War had been learnt, we must attribute the relative freedom from intestinal infections during the Great War. The investigations made during the War have advanced our medical and hygienic knowledge, and thus the Army will be able to repay its indebtedness to civilian sanitarians by adding to our means of preventing disease in the ordinary course of civilian life.

Radiophones.

(1) *Radio Phone Receiving: a Practical Book for Everybody.* Edited by Prof. Erich Hausmann. Pp. vii + 183 + 14 plates. (London, Bombay and Sydney: Constable and Co., Ltd., 1922.) 9*s.* net.

(2) *Direction and Position Finding by Wireless.* By R. Keen. Pp. xix + 376. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1922.) 9*s.*

(3) *Wireless: Popular and Concise.* By Lt.-Col. C. G. Chetwode Crawley. Pp. 92 + 8 plates. (London: Hutchinson and Co., n.d.) 1*s.* 6*d.* net.

(4) *The Wireless Telephone: What it is, and How it Works (including Directions for Building a Simple Receiver for Wireless Telephone Broadcasts).* By P. R. Coursey. Pp. vi + 113. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1922.) 2*s.* 6*d.*

(5) *Crystal Receivers for Broadcast Reception.* By P. W. Harris. Pp. 75. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1922.) 1*s.* 6*d.*

(6) *Mast and Aerial Construction for Amateurs: Together with the Method of Erection and other Useful Information.* By F. J. Ainsley. Pp. 82. (London: The Wireless Press, Ltd.: New York: Wireless Press, Inc., 1922.) 1*s.* 6*d.*

(7) *The Perry Auto-Time Morse System: an Aid to the Rapid Acquirement of Speed in the Transmission and Reception of the Morse Code.* By F. W. Perry. Pp. 16. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1922.) 6*d.*

A CONSTANT struggle has been going on for the last ten years between the users of the adjectives "wireless" and "radio." It is hoped that the question will be solved by international agreement. In America "radio" is in general use, but in this country it is probable that "wireless" will be used by many experts for several years to come. It is easily understood why authors who have written books on "wireless" should be loath to change, but that they should have a strong following seems odd. In our opinion, "radiophone" is a suitable contraction for "radio-telephone," and "radiophone communication" is better than "wireless telephone communication."

Whether we like it or not, there is no doubt that listening to radio broadcasting has become an everyday incident in many households. Until about November 1920 practically the only use of radio-communication was for signalling between pairs of stations. That a message sent out from a station could be heard simultaneously at many others was generally regarded as an inherent drawback to this system of communication, except in the case of a ship in distress on the sea. In the United States radiophone broadcasting began with news items and phonograph music. The latter item was not so good as having your own phonograph. You had to be content with a record chosen by somebody else, at a time which he thought best. The stations now send out vocal and instrumental music, time-signals, accounts of sporting contests, weather and stock-exchange reports, and so on. If broadcasting is to be a success, the programmes have to be good from both the recreational and educational points of view. The quality of the speech and music reproduced by the radiophones or the loud-speaking telephone must surpass the performance of a gramophone. The programmes must be sent out daily at definite times and with absolute punctuality. Lastly, inexpensive and easily operated receiving apparatus must be readily procurable.

A development which will probably take place in the immediate future is the simultaneous transmission of different programmes. This can easily be done by using different wave-lengths. The element of choice will certainly make the broadcasting more attractive. From the programmes published in America we learn that the radiophone "cheers the hospitals," brings "church services to the home-bound" and "entertainment and news to the isolated." A claim is also made that radio broadcasting tends towards greater national and international harmony.

On the other hand, Mr. Perry in the preface to (7) advises every one to learn the Morse Code so as to listen-in to radio-telegraphic messages, which, he says, is far more interesting than broadcast radiophone concerts. In his opinion the constantly changing personal messages sent out "open up a vast field of interest, amusement, and knowledge." His book is to help the reader "to maintain a healthy interest in such a wonderful subject." It seems to us that there is room for a book on the subject of the ethics of "listening-in" to urgent personal and farewell messages from, for example, passengers on board ship. This method of obtaining interesting and amusing knowledge would not appeal to every one.

(1) Prof. Hausmann's book describes in an excellent and simple way the methods and apparatus used for receiving radiophone speech and music. Nine of the most eminent experts in America have co-operated to produce a thoroughly good book which can be readily understood without special technical knowledge.

(2) Mr. Keen's book deals not only with the general principles of direction-finding, but also with the constructional details of the installations required for shore service and for the navigation of ships and aircraft. It will be appreciated by the expert, for, although the discussion of problems is usually rather elementary, it is very thorough. The nomenclature of the subject is not yet fixed and so the author occasionally uses alternative words. We thus find the "cardioid," the "heart-shape," and the "apple" diagram of reception. Occasionally the author gets tired of writing about the "Marconi-Bellini-Tosi" system and refers to it simply as the M.B.T. system. The notes on field and nautical astronomy given in the appendix are good and will be helpful to the engineer.

(3) Colonel Crawley's little book on wireless is popular and interesting. He points out that the enthusiasm for broadcasting may have drawbacks. In the United States it is sometimes called "radio-flu." The purchase of a cheap set may lead to grievous disappointment. He gives a thoughtful discussion of the Imperial Wireless Chain.

(4) Mr. Coursey discusses the essentials of a radiophone and how it operates. He uses "wireless" and "radio" indiscriminately. The book is nicely got up and will be useful to beginners.

(5) The fifth book on our list will meet the requirements of those who desire to construct their own apparatus. A detailed description is given of a high-grade crystal receiver suitable for the reception of the broadcast concerts and radio time-signals sent out by the Eiffel Tower station in Paris. It must be remembered, however, that the concerts broadcasted by the Hague are quite inaudible in even a good crystal receiver connected with a large aerial. They can be heard only by suitable valve apparatus.

(6) Full particulars are give in Mr. Ainsley's little book for erecting various kinds of masts and aerials. Although it is not essential to possess an outside aerial with every receiving set, yet, when economy is a consideration, it is an advantage to have one. A strong 36-foot mast is shown the cost of the material for which was only 25*s*.

(7) In the last book on our list the author describes an ingenious method of learning the Morse system rapidly. This book should prove very helpful to many amateur radio-telegraphists.

Those intending to listen-in to the broadcasting must remember that even the best loud-speaking telephones appreciably distort speech and music. They cannot be used, also, unless the signals be so strong that they are uncomfortably loud on the radiophones. As a general rule, if it is desired to make signals audible in a room by means of a "loud speaker" it is necessary to add a two-valve magnifier to a set which would give comfortable hearing when used with radiophones. The two-valve magnifier itself appreciably distorts speech, thus adding to the troubles of those who listen-in.

The "Chemical" Sense.

Smell, Taste, and Allied Senses in the Vertebrates. By Prof. G. H. Parker. (Monographs on Experimental Biology.) Pp. 192. (Philadelphia and London: J. B. Lippincott Co., 1922.) 10*s*. 6*d*. net.

THE mechanism of the senses of smell and taste is apt to be unduly neglected, probably on account of the fact that in civilised man these senses do not play a large part in intellectual processes. But they bring before us some interesting problems as to the nature of receptor organs in general. It will be remembered that the object of such organs is to excite a set of nerve fibres on the incidence of some external agency of such a kind or intensity as to be unable to affect these nerve fibres directly. This is done by the production of some powerfully stimulating agent in the receptor mechanism at the terminations of these nerve fibres.

It is difficult to define satisfactorily the difference between taste and smell. If it be said that the former relates to substances in solution, whereas the latter relates to vapours, we are met with the fact that even vapours must be dissolved in the watery layer covering the olfactory cells. Moreover, the presence in fishes of a mechanism which appears to be the same as that of smell in air-breathing organisms suggests the need of some other criterion. Prof. Parker directs attention to the lipoid solubility of odorous substances and to the existence of hairs composed of lipoid material on the olfactory cells. The relation of surface tension and adsorption has also been brought into connexion with odorous properties. When we come to attempt to correlate either smell or taste with chemical composition we are met with serious difficulties.

The sense of taste is shown to include at least four distinct senses—sour, saline, bitter, and sweet. Some interesting experiments are given on p. 161, which show that the catfish, Amiurus, responds to meat juice by means of taste-buds situated on the sides of the animal. What is also significant is that the response is accompanied by "local sign," just as touch is in ourselves. The fish is aware of the position of the stimulus, turns to it, and swallows the meat. The response is absent when the nerves to the taste-buds are cut.

Prof. Parker holds that the sensations produced by various chemical irritants are to be distinguished from those of pain, although both are devoid of differentiated receptor organs and are mediated by free nerve endings. The chemical sense is said to be abolished by a smaller dose of cocaine than is the sense of pain. They have in common, however, a high threshold value, as would be expected from the nature of the structures stimulated. As the object of the sensibility is mainly to avoid injury, too great a delicacy would clearly be a disadvantage. The last chapter of the volume contains an interesting discussion on the relations between the common chemical sense and those of smell and taste. Of the three the olfactory sense is regarded as the most primitive, that of taste the most highly developed, with the common chemical sense as intermediate in evolution.

The volume is a very useful summary of our knowledge on the subject of the "chemical" senses as a whole.

W. M. B.

Our Bookshelf.

Geologie in Tabellen für Studierende der Geologie, Mineralogie, und des Bergfachs, der Geographie und der Landwirtschaft. Von Prof. Dr. K. Andrée. Erster Teil. Pp. xv + 96. Zweiter Teil. Pp. 97-134. Dritter Teil. Pp. 135-228. (Berlin: Gebrüder Borntraeger. 1921–1922.) Three parts, 8*s*.

The most remarkable things about this representation in tables of matters with which the geologist has to deal are the ingenious industry of the author and the very moderate price at which the book has been so excellently produced. Whether it will appeal to students depends much on the individual frame of mind. We incline to think that the "Tabellen"—we had almost written "tabloids"—will be of most, and indeed of considerable, service in the private library, as reminding the worker of what to look for in larger and descriptive treatises. It is to be regretted that there is no index to the mass of information of an expected or unexpected nature here assembled.

The author, in view of the abundance of material, has wisely kept the classification of igneous rocks on very simple lines. The customary grading of the "fine earth" of soils is given in section B of Table 49. Prof. Andrée has directed attention to his use of graptolites and ammonites in the stratigraphical tables, and here the succession of strata in various regions is set forth under the several systems. The columns dealing with the later series naturally show far more detail than those relating to the Carboniferous and older systems. The full treatment of Cainozoic strata should go far to correct the notion of their relative unimportance that still prevails among geologists in the British Isles. This is, we fancy, the portion of Prof. Andrée's work that will be referred to most often.

Prof. Andrée in his last ten pages generously provides a list of authoritative modern works on geology, which will guide the student into more arcadian fields. With two exceptions in favour of the United States, and three of an international character, the books named are all in German, so that we miss Geikie's "Text Book," Haug's "Traité," and De Margerie's translation, virtually a revised and extra-illustrated edition, of Suess's "Antlitz der Erde."

G. A. J. C.

Reinforced Concrete: A Practical Handbook for Use in Design and Construction. By R. J. Harrington Hudson. Pp. xxiv + 318. (London: Chapman and Hall, Ltd., 1922.) 16*s*. net.

This volume is one of the very few treatises on reinforced concrete in which the properties of the materials employed, and the methods of working these materials so as to produce the finished results, receive adequate treatment. The matter is of great importance from the student's point of view; in too many instances, after a course in reinforced concrete, the impressions left in his mind are somewhat hazy, and he is apt to think that the subject is one consisting only of complex calculations. The early chapters in the book before us will go far to remove this impression. Most of the space is taken up with questions of design, both in theory and practice; the plan generally followed has been to give a general discussion of the particular problem, and then to throw the results into the form of tables and graphs so as to simplify so far as possible the practical work of the designer. The reader will find the numerous worked-out examples very helpful in gaining a knowledge of the methods of practical design. The portions dealing with monolithic design are good, and include discussions on secondary stresses and on continuous beams monolithic with columns. In developing this part of the subject the author successfully employs the equation of three moments. The London County Council reinforced concrete regulations are included in the volume, as also are extracts from the British standard specifications relating to Portland cement, and structural steel. The author is to be congratulated on his volume, which cannot fail to be of value both to engineering students and to those engaged on the practical side of structural engineering.

The Topography of Stane Street: a Critical Review of "The Stane Street," by Hilaire Belloc. By Capt. W. A. Grant. Pp. 95. (London: John Long, Ltd., 1922.) 5*s*. net.

In his critical review of Mr. Belloc's "Stane Street," Capt. Grant has produced a valuable study of this Roman way, which, although the author pretends to offer no opinion on historical or archæological points and confines himself to questions of topography, is of no inconsiderable interest to archæologists and students of Roman Britain. His criticism of Mr. Belloc is that, while an adept in map reading, his lack of familiarity with the principles of surveying for map construction has led him into numerous errors in tracing the alignments of Stane Street from Chichester to the site of Old London Bridge, sixty yards east of the modern bridge.

Mr. Belloc's theory is that there were four great limbs or sections covering respectively the ground from Chichester (east gate) to Pulborough Bridge, from Borough Hill to Leith Hill, from Leith Hill to Juniper Hill, and from Juniper Hill to the southern end of London Bridge. Capt. Grant examines each of these in detail and demonstrates the errors, while in a further chapter he indicates the true alignments and discusses the general principles upon which Stane Street would appear to have been planned. Capt. Grant is commendably precise in his criticisms, and in two appendices gives long lists, with references, of "Errors due to carelessness or Printers' Errors," and "Errors due to Miscalculation and mis-statements arising therefrom."

British Museum. Guide to the Maudslay Collection of Maya Sculptures (Casts and Originals) from Central America. Pp. 94+8 plates. (London: British Museum, 1923.) 1s. 6d. net.

To the small but select band of Americanists in this country it has always seemed little short of a scandal that the Maudslay Collection of Maya Sculptures, after being on exhibition for a short time at the Victoria and Albert Museum, should have been consigned to store, where it has remained for thirty years. Its rescue and display in the galleries of the British Museum pays a tardy tribute to Dr. A. P. Maudslay's pioneer researches and his enthusiastic efforts to preserve a faithful record of the remarkable artistic skill and culture of the ancient inhabitants of Central America. This collection of casts and originals was made by Dr. Maudslay, entirely at his own expense, between the years 1881 and 1894, when he made no less than seven journeys to Central America, visiting the principal sites in Yucatan, Honduras, and Guatemala.

The preparation of the guide to the collection has been in the competent hands of Mr. T. A. Joyce, who, in addition to a detailed description of the exhibits, has written an introduction dealing with the main characteristics of Maya culture and, in particular, with their hieroglyphic and chronological systems. It contains exactly the information necessary to enable the uninstructed visitor to the gallery to appreciate the most striking features of this ancient semi-civilisation.

Flora of the Presidency of Madras. By J. S. Gamble. Part 5: Ebenaceæ to Scrophulariaceæ. (Published under the authority of the Secretary of State for India in Council.) Pp. 769–962. (London: Adlard and Son and West Newman, Ltd., 1923.) 10s. net.

The present part of Mr. Gamble's Madras flora is on the same lines as previously issued parts. The family Ebenaceæ is completed, with an enumeration of the 24 species of Diospyros, several of which are large trees yielding a black heartwood, or ebony; and the treatment of the families of gamopetalous dicotyledons follows in the sequence usually adopted in the British Colonial floras. The principal families are Apocynaceæ, Asclepiadaceæ, and Convolvulaceæ, and the part concludes about half-way through Scrophulariaceæ. Solanaceæ is poorly represented, but in this family, as in Apocynaceæ, several South American genera, introduced in cultivation, have run wild. Mr. Gamble enumerates eight species of Strychnos, including *Nux vomica*, the source of strychnine, and another species, the seeds of which yield the alkaloid brucine; a third species, *S. potatorum*, derives its name from the fact that the seeds are used to clear muddy water. Of the Convolvulaceæ, the genera Argyreia and Ipomœa supply many showy-flowered climbers; *I. Batatas*, sweet potato, is in common cultivation as a vegetable.

Coal and Allied Subjects: a Compendium of the First Ten Bulletins issued by the Lancashire and Cheshire Coal Research Association. By F. S. Sinnatt. Pp. v+205. (London: H. F. and G. Witherby, n.d.) 15s. net.

Mr. Sinnatt and his collaborators have prepared a compendium of the first ten bulletins issued by the Lancashire and Cheshire Coal Research Association, and the intention of the publication is "to enable those engaged in the Coal Industry and others to share the knowledge gained in carrying out the work." The bulletins have been well worth collecting and issuing together in this form, which will facilitate ready reference. They vary in content from such a general subject as "Notes of Ten Introductory Lectures on Organic Chemistry, with Special Reference to Coal" (condensed into 32 pages) to the highly specialised brief bulletin on "Hoo Cannel." One of the most interesting describes the examination of the inorganic constituents of coal which deals with those ash inclusions known as ankerites, while "Coal Dust and Fusain" indicates another line of work with which Mr. Sinnatt has identified himself. No very fundamental problems of fuel technology have been attacked, and some of the matter is not original, being simply collected in the bulletins for the convenience of the Research Association, but it is a record of useful work. J. W. C.

The Phase Rule and its Applications. By Prof. Alexander Findlay. (Text-books on Physical Chemistry.) Fifth edition. Pp. xvi+298. (London: Longmans, Green and Co., 1923.) 10s. 6d. net.

The fifth edition of Prof. Findlay's book on the phase rule differs from previous editions in that the whole volume has been re-set, so that in spite of containing additional matter there is a substantial reduction in the number of pages. In the new edition the iron-carbon diagram has been altered in order to include the δ form of iron which appears when the pure metal is heated to 1400° or to a somewhat higher temperature in presence of carbon; the β form of iron has also been eliminated as differing only in magnetic properties from α-iron or ferrite. New material has also been introduced in connexion with the allotropy of sulphur and phosphorus, in view of the fact that these elements can give rise to pseudo-binary systems. In the later chapters of the book, additional space has been devoted to the mineral-forming systems, including both the aqueous deposits of the Stassfurt salt beds and the igneous calcium aluminium silicates.

Letters to the Editor.

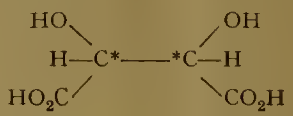
[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Molecular and Crystal Symmetry.

THE relation between the symmetry of a crystal and that of the component molecules has been recently discussed by G. Shearer (Proc. Phys. Soc., 1923, vol. 35, p. 81), who, unknowingly following the same train of thought, has arrived at the conclusion, previously stated by Fedorov (*Zeits. Kryst.*, 1912, vol. 52, p. 22), that a crystal obeys what may be termed a principle of conservation of symmetry. Thus, if n be the "symmetry number" of the structural unit or parallelepipedal brick (the number of identical or enantiomorphously related asymmetric parts into which it is subdivisible), m the number of molecules it contains, and p the symmetry number of each molecule, then $n/m = p$, or alternatively $pm = n$, *i.e.* the symmetry of the individual molecules multiplied by their number gives the symmetry of the crystal. If the formula be correct no symmetry is dissipated, the whole of the molecular symmetry being taken up by the crystal. Now, so far as Fedorov was concerned, the matter was purely speculative, for the X-ray method had only just been discovered and its exact meaning was still obscure, but Shearer has gone a step further by collecting X-ray data in support of the principle (or "Shearer's rules"), with the result that it has been provisionally adopted by Sir W. H. Bragg (Journ. Chem. Soc., 1922, vol. 121, p. 2766) as a working hypothesis in the interpretation of X-ray measurements. As I think the various considerations advanced by Shearer are inconclusive, and are already leading to very questionable conclusions concerning the stereochemical formulæ of certain aromatic compounds, I would here submit the Fedorov-Shearer principle to a brief discussion.

It is self-evident that any real vindication of the principle involves a knowledge of all the three terms p, m, and n of the formula. Now the last two quantities are relatively easily determined, but the molecular symmetry p is a much more difficult matter, for it implies a determination with a tolerable degree of accuracy of the position of every atom in the structure, and as such difficulties have not yet been overcome in the case of such complicated compounds as the benzene, naphthalene, and anthracene derivatives investigated by Sir W. H. Bragg, it is evident that the field for testing the principle is very restricted. As a matter of fact, the evidence adduced by Shearer is very scanty, consisting as it does of the demonstration that in no known case is $m > n$, followed by the statement that if certain values of p be allowed, then all the crystals can be brought into line with the principle. It must be noted that there is no experimental evidence in favour of these special p-values (which are, then, really postulated), and that most of them are not what one would expect from chemical knowledge (unless, of course, the molecular configuration in the crystal has not the same symmetry as it has in solution). Thus, crystal molecules of α- and β-naphthol, resorcin, benzoic, salicylic, and phthalic acids are all held to be asymmetric, from which it is to be inferred that the crystals contain two kinds of molecules in the manner of racemic acid. Then, again, naphthalene is held to have no plane of symmetry, and so on.

There is, however, one organic compound for which all the three terms p, m, and n have been reasonably well established, namely, the ordinary tartaric acid recently investigated by W. T. Astbury (Proc. Roy. Soc., 1923, vol. 102, p. 506). This is apparently held to conform with the principle, but as I do not agree with Messrs. Shearer and Astbury that the molecule is asymmetric, the case calls for a brief examination. The acid has long been known to have the formula



in which the two carbon atoms marked out by asterisks are the so-called asymmetric carbon atoms, *i.e.* atoms surrounded by four different groups in an asymmetric tetrahedral manner (the four groups being in each case H, OH, CO_2H, and CHOH . CO_2H). If a three-dimensional model be constructed according to the above scheme, it will be found to take three forms, depending on the way in which the duplicated groups H, OH, CO_2H are arranged about the main stem, C*——*C. One form is identical with its mirror-image (Pasteur's *meso* acid); the other two are non-identical mirror-images of each other (enantiomorphous) and represent the ordinary *dextro* acid of commerce and Pasteur's rare *laevo* acid respectively. It is the *d*-acid that is under examination, but the same will hold for the *l*-acid. If we inspect the model for symmetry we shall find a twofold (digonal) axis somewhere or other in the plane normal to the central stem, no matter how we may have previously affected the relative positions of the two ends by rotating one against the other (about the main stem). It may be added, parenthetically, that Astbury arbitrarily limits his discussion of the stereochemical model to six such positions, but in every case the molecular configuration of tartaric acid in the liquid or dissolved condition is not asymmetric (as generally described).

With regard to the state of the molecule in the crystal; a study of Astbury's paper leads me to the conclusion that the molecule is still symmetrical. The statement that "one-half of the ordinary tartaric molecule behaves exactly like the other half and is indistinguishable from it"; the pains that seem to have been taken to preserve this parity in allocating the various atoms within the structure; and, finally, the evidence of the numerous figures, all go far to counteract the impression created by Astbury's use of the term "asymmetric molecule." It seems as if the unobtrusive molecular twofold axis (normal to Astbury's "dumb-bell axis") has been overlooked. If this is so, then the state of affairs in a crystal of tartaric acid can be described as follows. The structure is not simply built up of a single space-lattice arrangement, with the molecular axes uniting to create the symmetry axis of the crystal, but is constructed of a pair of molecular lattices, mutually interpenetrating, the office of the second being to restore the symmetry lost by a refusal of the crystal to recognise molecular symmetry. As all the molecular symmetry is wasted, the Fedorov-Shearer principle is infringed to the utmost possible limit.

The above exhausts the material at present available for any practical discussion of the symmetry principle; for the numerous inorganic crystals reviewed by Shearer are evidently not put forward as proofs, but rather as contingent illustrations of the way in which the principle serves to limit the positions of the electrons in certain atoms. The conclusion must therefore be drawn that the principle has not been established. On the other hand, I am not disposed to attach too much weight to the evidence against the principle furnished by tartaric acid for the following reason. The object of Astbury's investigation was to explore the connexion between optical activity and enantiomorphism, and it was therefore necessary to choose a substance of relatively complicated composition. The crystals of tartaric acid are much too involved for any effective test of the symmetry principle. It is, for example, by no means certain that a slight deformation of the symmetrical crystal molecule into an asymmetric form could be detected by the X-ray method, and yet this deformation would be enough to substantiate the principle so far as tartaric acid is concerned.

It seems to me, therefore, that the whole question is still open, and that the suitable choice of material for an eventual test is worthy of a careful consideration. Such aromatic compounds as those under investigation for other purposes by Sir W. H. Bragg would seem to be unsuitable, for they are so complicated that the positions of the individual atoms cannot at present be deduced from the measurements; consequently, the shape and symmetry of the molecule have to be assumed. The compounds should rather belong to the simplest order of molecular structure; a molecule containing one atom of carbon is much better than one containing two. Hydrogen should be avoided, as it cannot be placed by the X-ray method. There should be as few kinds of atom as possible, for the quantitative connexion between atomic weight or number and reflection intensity is, perhaps, not too well known. The symmetry of the crystal should be beyond reproach, and it should be part of the investigation to assure it, since as a rule the crystallographer does not take the necessary trouble to determine the class of symmetry. Perhaps a suitable commencement might be made on carbon tetrabromide, CBr_4, the corresponding iodide and possibly hexachloro- and hexabromo-ethane (if these are not already too complicated). Such compounds have the advantage that the carbon content is almost negligible (being much less than the average percentage of hydrogen in organic compounds), and the X-ray effect of the carbon atom might therefore be neglected as a first approximation, the investigation being, as it were, simplified to that of a solidified bromine (or iodine) in which the halogen atoms are limited stereochemically by the insignificant carbon atom. Moreover, the dimorphism of the tetrabromide (monoclinic at ordinary temperatures and cubic above 49°) might afford information on the extent to which the molecular configuration changes with change of crystal structure.

Closely related with the above compounds are others of the same simple chemical type. Tin tetraiodide, SnI_4, for example, might give interesting results, since from the X-ray point of view the investigation might be regarded as that of an element (by virtue of the approximate equality in atomic number of tin and iodine), while from the chemical point of view one can be quite certain it is a compound (though whether the grouping of iodine atoms is tetrahedral is not so well grounded as in the case of a carbon compound). Work on such simple compounds as these might possibly establish the Fedorov-Shearer principle, and so be of assistance in the study of more highly developed carbon compounds.

T. V. BARKER.

University Museum, Oxford,
April 10.

Martini's Equations for the Epidemiology of Immunising Diseases.

E. MARTINI, in his "Berechnungen und Beobachtungen zur Epidemiologie und Bekämpfung der Malaria" (Gente, Hamburg, 1921), sets up a system of differential equations to represent the presumptive course of events in the development of an endemic in which recovery is accompanied by acquired immunity. He adopts the notation:

u = fraction of population affected with the disease, and infective.

i = fraction of population *not* available for new infection (immune or already affected).

$(1-i)$ = fraction of population *available* for new infection.

p = fraction of population newly affected, per unit of time.

q = fraction of affected population that ceases to be so, per unit of time, by recovery or by death.

m = fraction of immune population which loses immunity or dies, per unit of time.

α = infectivity (a proportionality factor).

Martini puts the new infections, p per unit of time, per head of population, proportional both to the infective fraction u of the population, and also to the fraction $(1-i)$ of the population *available* for new infection, so that $p=\alpha u(1-i)$, and accordingly writes his equations:

$$\frac{du}{dt}=\alpha u(1-i)-qu=(\alpha-q)u-\alpha ui, \quad . \quad . \quad (1)$$

$$\frac{di}{dt}=\alpha u(1-i)-mi=\alpha u-mi-\alpha ui. \quad . \quad . \quad (2)$$

Martini remarks that these equations cannot be integrated in finite terms. They are of a type discussed by the writer elsewhere (*American Journal of Hygiene*, January Supplement, 1923). Their solution in series is

$$u=P_1e^{(\alpha-q)t}+P_2e^{-mt}+P_{11}e^{2(\alpha-q)t}+P_{22}e^{-2mt}+\ldots \quad (3)$$

$$i=Q_1e^{(\alpha-q)t}+Q_2e^{-mt}+Q_{11}e^{2(\alpha-q)t}+Q_{22}e^{-2mt}+\ldots \quad (4)$$

From this it is seen that:

(1) The equilibrium at the origin ($u=i=0$) is stable if, and only if, $\alpha<q$. When this condition is satisfied, the disease will die out.

(2) The solution near the origin cannot take on oscillatory form, since $(\alpha-q)$ and m are necessarily real quantities.

There is, however, another equilibrium (as pointed out by Dr. Martini), namely, at

$$u=\frac{m(\alpha-q)}{\alpha q}=\mathrm{U}, \text{ say}, \quad . \quad . \quad . \quad (5)$$

$$i=\frac{\alpha-q}{\alpha}=\mathrm{I}, \text{ say}. \quad . \quad . \quad . \quad . \quad (6)$$

This has a real meaning if and only if $\alpha>q$, that is to say, just in that case in which the equilibrium at the origin is unstable; at the same time, in the neighbourhood of $u=\mathrm{U}$, $i=\mathrm{I}$, we have again a solution—

$$(u-\mathrm{U})=P'_1e^{\lambda_1t}+P'_2e^{\lambda_2t}+P'_{11}e^{2\lambda_1t}+\ldots \quad (7)$$

$$(i-\mathrm{I})=Q'_1e^{\lambda_1t}+Q'_2e^{\lambda_2t}+Q'_{11}e^{2\lambda_1t}+\ldots \quad (8)$$

where

$$\lambda=-\tfrac{1}{2}\left\{\frac{\alpha m}{q}\pm\sqrt{\frac{\alpha^2m^2}{q^2}-4(\alpha-q)m}\right\}. \quad . \quad (9)$$

We need here give no further consideration to the case $\alpha<q$, since the second equilibrium has no real existence in this case, and the first equilibrum was found to be stable, the disease dying out.

In the other alternative, namely, $\alpha > q$, we have two cases to distinguish :

$$(1) \quad . \quad . \quad . \quad . \quad . \quad (\alpha - q) < \frac{\alpha^2 m}{4q^2}.$$

In this case λ_1 and λ_2 are both real and negative. The equilibrium at U, I is stable, the disease will become definitely established, if once started. The approach to equilibrium is aperiodic, asymptotic.

$$(2) \quad . \quad . \quad (\alpha - q) > \frac{\alpha^2 m}{4q^2}, \quad \text{or} \quad \frac{m}{q} < 4\frac{q}{\alpha}\left(1 - \frac{q}{\alpha}\right).$$

In this case λ_1 and λ_2 are complex, with negative real parts. The equilibrium at U, I is still stable, but will be approached by a periodic process of damped oscillations.

It may be remarked that a solution can still be given if the coefficients α, m, q, which have here been treated as constants, are regarded as periodic or even as general functions of the time. However, the numerical evaluation of the coefficients appearing in the solution then becomes very onerous. It will suffice, on this point, to refer to the pertinent mathematical literature, as, for example, Picard, "Traité d'Analyse," 1908, vol. 3, pp. 187, 188, 194, 197; Goursat, "Traité d'Analyse," vol. 2, 1918, pp. 482, 498.

ALFRED J. LOTKA.

Johns Hopkins University.

The Cause of Anticyclones.

IF space permits, I should like to reply to one or two points in the letter contributed by Mr. W. H. Dines to NATURE of April 14, p. 495.

(1) In the first place, when one is dealing with two different sorts of air, probably of unequal frequency of occurrence, it appears to me to be unsafe to depend very greatly on comparison with mean values derived from all cases considered *en masse*. Has not the Bjerknes theory been elaborated as the result of an attempt to deal with the problem of atmospheric circulation on the assumption that discontinuities might exist, and that therefore—as other methods would probably fail to reveal them—only close study of individual cases could hope to succeed?

Apart from this, Mr. Dines deals with departure of temperature from the mean for the *height* and date. In the paper (Q.J.R. Met. Soc., Jan. 1923) to which reference was made in my earlier letter (NATURE of March 31, p. 429) temperature is dealt with throughout in relation to given *isobaric surfaces*. This seemed particularly desirable in the case of polar air, for a mass of such air, leaving polar regions with high velocity and low barometric pressure, may eventually find itself, with much reduced velocity and with a pressure increased by some 20 to 30 millibars, forming the surface layers of an anticyclone in temperate regions. The corresponding adiabatic increase of temperature (communication of heat from warmer seas, etc., being left out of account as being more or less common to all polar air moving southward) would be 3° to 5° F., or enough to bring the temperature at a fixed *height* up to about the mean temperature for that height. If the fifty-two cases of anticyclones referred to by Mr. Dines are considered from the point of view of normal temperature for a given pressure it will be evident that about half must be of polar air up to 1 km., and I think this is about as large a proportion as I should claim for that level. Rather more than one-fifth would then be polar up to 3 km., and so on.

(2) The question in regard to humidity is very complex; but I have always taken exception to the view that humidity (either relative or absolute) would be of much value in distinguishing between polar and equatorial air apart, that is, from its value for locating the discontinuity. In particular, polar air, in its passage over warmer seas, should have its humidity at all heights affected quite as greatly as its temperature. Equatorial air, on the other hand, is being cooled in its surface layers in the course of its northward journey, and the cooling effect does not tend to be propagated upward to any comparable extent; such factors as are at work within equatorial air tend rather to rob it of its water vapour without renewing the supply.

I do not, therefore, consider that where polar air lies under equatorial air the inversion of temperature need necessarily be associated with any particular peculiarity as to relative humidity. At the same time, the conspicuous decrease of relative humidity is well known and appears to be common, at least to all inversions in anticyclones. It may, therefore, be a natural sequel to the inversion itself, and I offer an explanation which seems to me not altogether impossible. It is that the inversion of temperature once formed acts as a non-return valve to moisture (in the same way that it almost certainly does to dust and haze in the atmosphere), and that very soon the "convectional lid" accumulates a concentration of water vapour just beneath it; the layer of air just above, on the other hand, succeeds in passing on upward or allowing to drop below the greater part of both its dust and its moisture while replenishment of these from below has ceased.

A. H. R. GOLDIE.

Wimbledon, S.W.19,
April 26.

THE reply of Mr. W. H. Dines, in NATURE, April 14, p. 495, to Major Goldie's letter, brings out very convincingly the peculiar fact that the temperature conditions of the troposphere, both in cyclones and anticyclones, are such as would rather obliterate than maintain them. Indeed, when we consider the problem of pressure distribution, we find that the conditions are generally exactly the reverse of those required by the ordinary accepted theory, except in latitudes within the tropics of Capricorn and Cancer. We are thus faced with a very striking theoretical difficulty; for the winds of the earth do not appear, in the main, to derive their force and direction from the temperature conditions at or near the earth's surface.

One of the most marked effects of surface temperature on the pressure distribution, other than the phenomena of the trade winds, is the fact that along the high-pressure belts of the tropics the pressure is greatest over the cold land masses during the winter and lowest over the heated land masses during the summer. Another clear effect of surface temperature is the fact that the North Pacific cyclone and the North Atlantic cyclone (the eyes of the North Polar cyclone) are more powerful during the summer than they are during the winter. However, we have to set against these considerations the striking facts that throughout the year the great low-pressure areas are over the frigid poles, which are not even exposed to the sun's rays during the winter, and that the high-pressure belts are near the tropics of Cancer and Capricorn, and cover the intensely-heated desert lands of the continents. To surface temperatures, on the other hand, must be ascribed the great seasonal changes of pressure and temperature which occur over the elevated areas of Asia.

When considering the theory of anticyclones and cyclones, it is better to pay attention to the great permanent features shown by the distribution of atmospheric pressure over the earth's surface. It is to these that the prevalent winds of the atmosphere are due. Small travelling cyclones are of course interesting; and, strange to say, they show the same peculiarities of pressure and temperature distribution as do the much larger permanent cyclones. Everything points to the conclusion that there is some other force at work more potent than the temperature conditions in the troposphere; and I have suggested that this force arises from differences of temperature in the upper stratosphere.

It is true that many registering balloon ascents show an isothermal condition in the lower stratosphere; but others show quite a rapid rise of temperature with increasing height. A study of these curves led me to conclude that at a height of 60 km. the temperature approaches very nearly that of the earth's surface. That such is the case a study of meteoric phenomena has demonstrated. Now if the distribution of temperature near the limits of the upper atmosphere varied with the latitude, the pressure distribution at the earth's surface would be affected. It seemed natural to suppose that such heating would be greater over the equatorial than the polar regions; but if this were so, the low-pressure areas would be in low latitudes and the high-pressure areas in high latitudes; which is not the case.

The above considerations suggested that the upper atmosphere must be hotter over the poles than it is over the equator; for, if such were the case, all our difficulties in trying to account for the pressure distribution and directions of the winds would vanish. However, there are several peculiar phenomena of the polar areas, such as the aurora borealis, which require explanation as well. This is a matter which cannot be adequately discussed in a short letter; but it is probably due to the deflexion of electrons, etc. (shot out by the sun), towards the polar areas by the earth's magnetic field.

It has been objected that my theory necessitates vertical currents in the stratosphere, which the temperature conditions would not permit. The actual temperature conditions would certainly retard the equalisation of pressure by vertical movements in the stratosphere, and this would cause it to take place mainly in the troposphere. It may be that it is this that makes it appear as though the force maintaining cyclones resided at the upper surface of the troposphere, as Mr. W. H. Dines points out in one of his papers. Indeed, the inrush due to the friction of the air with the earth's surface in a cyclone would lead to an outrush at the top of the troposphere.

It is admitted that there are difficulties in the theory which remain to be explained; but they seem less than those met with when other theories are considered.

R. M. Deeley.

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Physical Literature on the Continent.

During the last few years it has become increasingly difficult for the universities of Central Europe to procure the scientific journals of other countries, in consequence of the calamitous depreciation of German and Austrian currencies. Such a state of things acts as a deterrent to scientific advancement in that the knowledge of work done outside only slowly and imperfectly permeates into these countries through indirect channels. Quite recently I have had two letters from continental physicists in reference to this matter, and I am anxious to bring the facts to the notice of the readers of Nature, in the hope that something may be done to remove to some extent the difficulty which at present exists.

Prof. Benndorf, of the Physical Institute of the University of Graz, Austria, informs me that the last number of the *Philosophical Magazine* available in that city is that of July 1914. In view of the expense, it has been quite impossible for them to procure back numbers of this and other English scientific journals, or to maintain them at present, as will be realised from the fact that the equivalent in our money of the annual grant to the Physical Institute of that University amounts only to 23*s*. The unsatisfactoriness of such conditions is obvious.

As it is not difficult in the libraries of most of our university towns to procure at least one copy of the *Philosophical Magazine*, it has occurred to me that perhaps some reader of Nature might be prepared to assist the Graz Physical Institute, by handing over his copy of the *Philosophical Magazine* to that institution say at the end of each month of issue. Such a donation would be most acceptable, and the donor may be sure of the sincere gratitude of the recipients, some of them well known in physics, such as Benndorf, Kohlrausch, and Hess.

The second letter has reference to the Physical Institute of the University of Berlin, which, for like financial reasons, is no longer in a position to purchase the *Philosophical Magazine*. Several members of this Institute, including Prof. Pringsheim, Dr. Hettner, and Dr. Laski, have suggested to me the possibility of surmounting the difficulty by an exchange of periodicals such as has already been arranged with America. They propose an exchange of the *Philosophical Magazine* as issued for either the *Zeitschrift für Physik*, *Die Naturwissenschaften*, or some other journal to be arranged upon.

If any reader of Nature feels disposed to assist in respect of either of the above suggestions, I shall be glad if he will acquaint me of the fact, so that I may put him in touch with the Institutes referred to.

Robert W. Lawson.

The University, Sheffield, April 18.

Chloroplasts and Cells.

In an interesting account of studies with the variegated variety of the fern *Adiantum cuneatum* in the March issue of the *Journal of Genetics*, Miss Irma Andersson shows that the prothallia all sooner or later develop whitish stripes in which the chloroplasts are pale green and only half the size of the chloroplasts in the surrounding green cells. There are no intermediates, nor does any cell contain chloroplasts of both types. The purpose of this note is to direct attention to certain facts which appear to have a bearing on this sharp segregation occurring in gametophyte tissue.

There is evidence from several sources that the size of the chloroplasts in a cell is controlled and determined by the size of the cell, or, at any rate, that whatever determines the one also controls the other. Thus in tetraploid forms of *Solanum nigrum* and tomato produced by grafting, Winkler (*Zeitsch. f. Bot.*, 8: 417-531, 1916) has shown that the chloroplasts and starch grains as well as the cells and nuclei are approximately twice their normal size. Similarly, in the tetraploid *Œnothera gigas* it has long been known (Gates, *Arch. f. Zellforsch.* 3: 525-552, 1909) that the cells and nuclei are conspicuously larger than in the parent form, and van Overeem has shown recently

(*Beih. z. bot. Centlbl.* 39 : 19, 1922) that the same applies to the chloroplasts and to the xanthophyll grains in the petals. Also in the experiments of Bottomley (Proc. Roy. Soc. B, 89 : 481-507, 1917), on the effect of auximones in stimulating the growth of Lemna, his figures show (see pl. 22) that not only the cells and nuclei but also the chloroplasts are conspicuously increased in size.

In *Œnothera gigas* the gigantism of these structures is inherited, while in the Lemna experiments presumably it was not. Incidentally, this is an example of the same character being inherited in one case and not in another. But in its bearing on the fern chloroplasts it is interesting as showing how the cell as a whole controls the characters of its contained chloroplasts. The abrupt change from large dark to small pale chloroplasts in the fern prothallia seems to be of the nature of an "all or none" reaction in the genesis of the cell.

That such abrupt transitions do not always occur, however, is shown by certain striped varieties of maize (Randolph, *Bot. Gazette*, 73 : 337, 1922) in which there is a transition zone where the cells contain plastids of many intermediate sizes and depths of colour even within a single cell.

R. RUGGLES GATES.

King's College, Strand,
London, W.C.2,
April 18.

Nightingale in Uganda.

ORNITHOLOGISTS may be interested to know that in March, when in camp in the part of the Northern Province of Uganda known as West Madi, on two successive mornings I heard a nightingale singing vigorously about 8-9 A.M. : the bird did not commence at daybreak, nor did he sing at night.

From the unfinished character of the song, and the lack of fulness and richness of the notes, I suspected that the individual was a young bird which had not yet fully developed his powers.

My attention was attracted on March 13, the day I reached the camp, about 8.30 A.M., by the familiar sound, so different from that of any African bird of the locality : unfortunately, I could not see the bird in the thick bush. The spot was just such as would have been chosen by a nightingale in England : a large clump of big trees with underbush like a small copse.

The camp was Moyo, about twenty miles west of the Nile and some ten miles south of the Uganda-Sudan frontier.

I should be glad to know whether nightingales are often heard to sing south of the Sahara. I imagine that this bird was perhaps making its way northwards from its winter quarters.

G. D. HALE CARPENTER.

Uganda Medical Service, Khartoum,
April 23.

Photography of Balmer Series Lines of High Frequency.

I HAVE recently performed a simple experiment with the luminous discharge through hydrogen, which has given results of some interest.

As is well known, it is difficult in the laboratory to photograph more than the first few members of the Balmer series, although higher members are well developed in the stars and nebulæ.

Prof. R. W. Wood has shown recently that fifteen or twenty of the Balmer lines can be photographed in a specially constructed tube running under very particular conditions, but I have found that an easy way of securing what appear to be similar results is merely to evacuate the hydrogen tube to a very low point, and then to cause the discharge to pass by the use of a glowing cathode.

Under these conditions, the Balmer series is brightened relatively to the secondary series ; moreover, the brightness of the higher frequency lines is enhanced.

The experiment is clearly suggested by the atomic model of Bohr.

I hope to publish a detailed account of the investigation shortly, as I am not aware of any previous experimental work along these particular lines.

R. WHIDDINGTON.

The University, Leeds,
April 21.

Mechanism of the Cochlea.

I THINK it is evident that Prof. H. E. Roaf (NATURE, April 14, p. 498) and I approach the problem of the action of the cochlea from different aspects. He says : "A variation in pressure applied to the *fenestra ovalis*, if it is to cause a movement of the basilar membrane, must cause movement of the liquids in the cochlea." Most writers on the cochlea have started with this assumption, which is fundamental for the theories of Wrightson, Lehmann, Meyer, ter Kuile, and Hurst. But it is not possible to explain in this manner the fact that sounds can be conducted through the bones of the skull, and analysed in the cochlea in the same way as air-borne sounds. The bone-conducted sounds must be conveyed through the cochlea fluids to the basilar membrane as waves of condensation and rarefaction in the fluid. The impulses thus given to the basilar membrane must set swinging the sector of the basilar membrane in tune with their frequency. It is impossible for the sector to move without setting in movement the fluid columns between the sector and the round and oval windows which constitute its "load." Thus, the movement of the cochlea fluid originates *at the basilar membrane*. This phenomenon of bone conduction is illustrated quite clearly in my model, which gives localised responses at the same levels whether the tuning-fork is applied to the stapes or to the front or back of the brass case.

There is no reason to suppose that the case is different for air-borne sounds. We can state positively that the waves of sound do produce alternating pressure changes in the cochlea fluid, but we cannot be certain that any movement of the cochlea fluid results from these pressure changes until one or more of the sectors of the basilar membrane is set swinging.

Regarding the action of the cochlea entirely as a resonance manifestation, fluid friction counts only as a damping factor. It has important bearing on sharpness of resonance and persistence of vibration, but its magnitude is very difficult to estimate.

I am afraid I do not quite follow Prof. Roaf's suggestion as to the spiral ligament. He says "the greater bulk of the spiral ligament [in the basal coil] may be merely to resist a greater strain." Does he mean bending strain or breaking strain ? If the former, the only way in which it could so act would be by producing increased tension, as I (following Gray) have supposed. If the latter, the breaking strain of the basilar membrane would be determined by the strength of its weakest part. However strong the spiral ligament might be, it could not prevent the basilar membrane being torn if excessive force were applied to it. GEORGE WILKINSON.

387 Glossop Road, Sheffield.

Breeding Experiments on the Inheritance of Acquired Characters.[1]

By Dr. PAUL KAMMERER, University of Vienna.

ALMOST a quarter of a century has passed since I commenced to examine the inheritance of certain breeding- and colour-adaptations which I had obtained with amphibia and reptiles. I did not expect, in relatively so short a time, to obtain positive results, and, moreover, I was then well under the spell of Weismannism and Mendelism, which both agree that somatic characters are not inherited.

In the year 1909 I succeeded in ascertaining that *Salamandra atra* and *Salamandra maculosa* can be so bred as to produce a complete and hereditary interchange (of reproductive characters). The fact that *Salamandra atra,* which propagates itself in a highly differentiated manner, can be made to propagate itself in the manner of *Salamandra maculosa* need not necessarily be regarded as the acquisition of a new character, but may be an atavism. Since, however, the breeding habits of *Salamandra maculosa* can be changed to those of *Salamandra atra,* this objection is (in this case) excluded. I have hitherto always believed that no true inheritance underlay this phenomenon, but only the appearance of heredity (*Scheinvererbung*)—the external conditions applied (such as moisture) affect the germ plasm in the direct physical and not primarily physiological manner.

In view of my researches on the change of colour in *Salamandra maculosa* I could no longer entertain this belief. If the young animals are kept on a black background they lose much of their yellow marking and, after some years, appear mainly black. The offspring of these, if kept again in black surroundings, bear a row of small spots, chiefly in the middle line of the back. If the offspring, however, unlike their parents, are reared on a yellow background, these spots fuse to a band.

The yellow markings of the parent generation reared in yellow surroundings increase at the expense of the black colour of the Salamandra. If now the descendants of such strongly yellow individuals be kept on a yellow background, the yellow portions grow and appear as wide bilateral stripes. Descendants, however, which, unlike their parents, are now kept on a black background have less yellow, but proportionately far more than the background produces in the offspring of parents raised in black surroundings. The yellow markings are arranged symmetrically in rows of spots on both sides of the body.

It could now be said that the diminution of that colour which in the parents has become increased exhibited the nature of a non-inheritance. The acquired colour does not remain constant but diminishes. Ultimately, the grandchildren would have regained the same colour distribution as that of the initial parents. Therefore it could be argued we have merely an *after-effect* and *not* inheritance.

Against this view, however, we have to consider several points. (1) Young Salamandra kept on a black background, and reared from parents which had not been kept in yellow surroundings, become blacker in a much shorter time than those (on a black background) which had been reared from parents kept in yellow surroundings. (2) The descendants in my experiments are not merely placed in intermediate conditions (for example, a mixture of yellow and black backgrounds), as was done in most other breeding experiments on the inheritance of acquired characters—for example, those of Standfuss and Fischer on butterflies and of Sumner on mice. But the descendants are placed in opposite conditions: strongly yellow Salamandra are placed on a black background, and *vice versa*. Each tendency must be neutralised by the opposing stimulus; it cannot be thought that living matter behaves in this respect differently from non-living matter. (3) The yellow colour of the Salamandra, which descends from parents which have become very yellow, has at first a tendency to increase in spite of the opposing effect of black surroundings. The rows of spots of the freshly metamorphosed animals tend to fuse into stripes, just as in the case of animals brought up on a yellow background. Only later these stripes break up into spots again.

Curt Herbst, in 1919, reproached me by saying that I did not mention the augmentation of yellow pigment on a black background, and *vice versa*. It can be seen from my slides, which I have already shown in 1909 to the Congress of German Naturalists in Salzburg, and in 1910 to the International Zoological Congress in Graz, that I have made this augmentation clear. I have always emphasised this phenomenon of inheritance, which Herbst did not recognise as such.

Finally, we must not neglect how I have selected my material. For the experiments on a black background I used Salamandra which were richly marked with yellow; for those on a yellow background, Salamandra which were least marked with yellow. I used, therefore, a negative—or contra—selection to exclude the objection that I was using animals specially suitable for the colour changes which they had to undergo. I had, indeed, to contend with the fact that my animals were specially unsuitable for the experiments. Those which would have to change their colour to black were apparently burdened with a tendency to yellow, while the others which would have to produce a yellow race would have to contend against an opposing inheritance influence.

In the Vienna woods, where I had myself collected my experimental material, there were only asymmetrically spotted Salamandra (*forma typica*). My breeding experiments had changed the spotted Salamandra into the striped form. The striped race (*forma taeniata*) occurs also in the open; it is true, not in Vienna, but in districts where the earth is coloured yellow or yellowish red. In the experiments which I am about to describe I used Salamandra from the Harz Mountains, and it was found that the young of these (as in the experiment) immediately after metamorphosis already possessed their *taeniata* markings. In another case, that of Salamandra originating from the surroundings of Heidelberg, the freshly metamorphosed young were irregularly spotted, as in *forma typica*, and only arranged their markings during their growth into *taeniata*. Curt Herbst has noticed this ontogenetic recapitulation,

[1] Lecture delivered before the Cambridge Natural History Society on April 30.

and has therefore unwittingly confirmed my breeding experiments. The development of *typica* into *taeniata* is reversible, for it also happens that *forma taeniata* will change back to *forma typica*. Mr. E. G. Boulenger has confirmed this in experimental animals which he kept in the larval condition on colour backgrounds. He obtained in this way results far more beautiful and significant than my own.

At the end of the experiments, then, I have two types of striped Salamandra: first, the Salamandra which are found in Nature; and, secondly, those which have been bred in the laboratory from spotted parents. The former is an anciently established natural race, the latter a "new" laboratory race, and both of these are externally identical. I used both types for inter-crossing and inter-transplantation and also to complete my transmutation experiments.

If spotted Salamandra be crossed with naturally striped Salamandra, the offspring are of either one race character or the other in the Mendelian fashion. Spottedness is dominant over stripedness. If one crosses naturally spotted Salamandra with experimentally striped Salamandra the hybrids are of an intermediate character (stripe-spottedness) and Mendelian segregation does not occur. The hybrid indicates therefore a difference between "old" and "new" characters, even though it happens that externally both are identical. Doubtless both are heritable, but only the long-established race characteristic obeys the Mendelian laws. The new characteristic does not exhibit any atavistic tendency toward the grandparent race. These facts acquire a special interest when we recall that the vast majority of Mendelian experiments has been done on long-established race characters.

These old and new characteristics can be distinguished, not only by means of crossing-experiments, but also by means of experiments on ovarian transplantation. If ovaries of spotted females are transplanted into the naturally striped ones, then the appearance of the young is determined by the origin of the ovaries—according to the *true* mother and not according to the foster-mother. They are always irregularly spotted. If, on the other hand, ovaries of spotted females are transplanted into artificially striped ones, then, if the father is spotted, the young are line-spotted; if the father is striped, the young are wholly striped.

The ovary of the spotted female brings into the body of the naturally striped foster-mother only its own hereditary properties as effective in fertilisation. In the body of an artificially striped foster-mother this same ovary behaves as if it had been derived from the body of a striped female and as if the eggs of the striped female had been used in the crossings.

The objection cannot be raised that the operation was not thorough—that portions of the original ovaries may have been left behind in the foster-mother, as in Guthrie's experiments on fowls, which were afterwards tested by Davenport and found to be merely cases of regeneration of the original ovaries. Thanks to its enclosing membrane, the ovary of the Salamandra can be removed from the surrounding tissue as a whole. It is impossible that any remnants could have been left behind and that the descendants were derived from these remnants regenerated.

These experiments on ovarian transplantation first led me to consider the possibility of the true inheritance of somatic characters. This conception of mine was supported by the experiments of Secerov, who, to begin with, had obtained analogous changes in *Salamandra maculosa* (*forma taeniata*) by influencing the larvæ. Secondly, Secerov had measured the amount of light which was able to penetrate the interior of the body of the Salamandra. Only one-sixth of one per cent. of the outer light reached the ovaries, and the colours of the surroundings were reduced by absorption by the skin. It is improbable, therefore, that there could have been any direct colour influence on the cells of the ovary and a colour-adaptation by "parallel induction." After considering this, together with the results of transplantation, only one plausible hypothesis remains, namely, that the colour changes become inherited by a "somatic induction"; by a process similar to, if by no means the same as, that which Charles Darwin had already imagined in his theory of Pangenesis and Cunningham and Hatschek brought forward later on to explain the phenomena of heredity.

The different reactions of old and new, inherited and acquired, characters in transplantation and crossing, I have tried to make intelligible by an analogy, I must confess, provisional and crude. A new piece of clothing irritates, but this irritation diminishes the longer the clothing is worn, and it ultimately disappears. Likewise, there is a morphological irritation from each part of the body, and this diminishes in the same way. When there have been recent changes the irritation is stronger. Under suitable conditions of duration and intensity the irritation penetrates to the germ plasma. There it renders permanent a potentiality for repetition of the actual change which brought it into play. In a new character, as time goes on, the morphological irritation diminishes. Its germ-plasmic induction is no longer effective. It now belongs to the past. For the present it is no longer necessary, because without it the corresponding tendency is fixed in the germ cells. The *inductive dependence* is a relation existing between the germ plasm and only newly acquired characters. Between germ plasm and old characters, the morphological irritation of which has by use long since disappeared, there exists a complete independence as demanded by Weismann's theory and proved by Mendel's experiments.

I will now touch briefly on further results of my experiments, though these now deal not with inheritance but with changes induced on one generation. Since it is just these experiments which are cited as evidence against the inheritance of acquired characters, it will not be out of place to give a brief refutation of this, as I think, mistaken interpretation. I have succeeded in developing the rudimentary visual organ of Proteus unto a full-sized functioning eye by red illumination to which the animals were exposed for five years from birth. The degeneration of the eyes in cave-dwelling animals, according to the other view, cannot be made hereditary. It is only a non-hereditary modification, a mere environmental change. Otherwise it would be impossible, by exposure to light for a single generation, to undo what life in darkness for so many generations had produced.

What contradicts this view is that exposure to ordinary daylight is not effective. In daylight the skin which covers the rudimentary eye is filled with a dark pigment. This considerable but by no means complete absorption of light due to the pigment is sufficient to arrest the development of the eye, so that the normal degeneration occurs. Red light, however, causes no pigmentation in the skin, and only under the influence of this chemically inactive light is the regression overcome.

The misinterpretation of these data allows me to make a further general observation. In order to prove completely that acquired characters are inherited we must produce at least one alteration of an inborn property. But if we only recognise those properties as hereditary which are unchangeable, then we have *from the very outset* excluded all heritable transformations, and at the same time rendered useless any investigations of the matter. If that which changes cannot be hereditary, and if that which is hereditary cannot change, we can only predict the immutability of species and therewith dogmatically leave on one side, not only the inheritance of acquired characters, but also the whole theory of evolution.

All existing objections, which rendered insoluble the inheritance of acquired characters, apply also to my breeding experiments on Alytes, and I myself would not have attached any special significance to this were it not that it is a result of just these experiments which has aroused the keenest interest in England—the development of a nuptial pad in the male Alytes. In male frogs, which pass their mating-time in water, there appears before mating, usually on the inner fingers, a rough, horny, glandular, dark-coloured pad. On the other hand, in Alytes, which mate on land, no trace of such a pad is to be seen. Yet it can be made to appear after several generations by compelling the Alytes to mate in water, like other European frogs and toads. This compulsion is brought about by raising the temperature, under which condition the mating animals stay longer in the water than usual, for if they did not do so they would run the risk of being dried up. Later in life compulsion becomes unnecessary. The stimulus of warmth produces an association through which henceforward the Alytes take to the water of their own accord when they wish to mate.

Of the many changes which gradually appear in this water breed during the various stages of development—egg, larva, and the metamorphosed animal, young and old—I will describe only one, the above-mentioned nuptial pad of the male. At first it is confined to the innermost fingers, but in subsequent breeding seasons it extends to the other fingers, to the balls of the thumb, even to the underside of the lower arm. After spreading, it exhibits an unexpected variability, both in the same individual and between one individual and another. The variability in the same individual is shown by the characters altering from year to year and in the absence of symmetry between the right hand and the left. In one specimen the dark pad extended to all the other fingers and almost over the whole of the left hand. On the right hand it was never so marked, and it was even less developed later, because the skin was stripped from this hand in the living animal for the purpose of histological investigation. The present skin and pad formation next to the inner finger is to be ascribed to regeneration in the mating season which followed. Microscopical preparations show the difference between the thumb skins of the mating male Alytes in the control breed and the padded skins of the water breed. The skin on the thumb of the normal male is subject likewise to an annual change in thickness. Alytes has already in its natural state a tendency to pad formation, and therefore does not display such a striking novelty as microscopic observation would lead one to think.

The great variability and extent of the pad, which can be produced by cultivation, and its independence of the testes, as castration experiments show, render the hypothesis possible, that what we are dealing with is an artificial creation of a new function. On the other hand, the Alytes pad can be interpreted as an atavism; or again, since the tendency was already there, one can quite well deny that the character has been acquired. Further, the influence of the heat responsible for the change penetrates the whole body of the cold-blooded animal and may therefore penetrate to the germ plasm in a purely physical manner. It is true that when four generations have altered in a similar manner, even after the stimulus has been removed, it is not very plausible that parallel induction should be the cause, and the subsequent appearances a mere after-effect. But as the atavism objection can always be raised, it is not very clear to me why just this experiment (with Alytes) is so often looked upon as an *experimentum crucis*. In my opinion it is by no means a conclusive proof of the inheritance of acquired characters.

Not content with any of the previous experiments, I carried out, before 1914, what may really be an *experimentum crucis*. I have written a few words on it in my "Allgemeine Biologie." There has been no detailed publication as yet. The subject is the Ascidian, *Ciona intestinalis*. If one cuts off the two siphons (inhalent and exhalent tubes), they grow again and become somewhat larger than they were previously. Repeated amputations on each individual specimen give finally very long tubes in which the successive new growths produce a jointed appearance of the siphons. The offspring of these individuals have also siphons longer than usual, but the jointed appearance has now been smoothed out. When nodes are to be observed, they are due not to the operation but to interruptions in the period of growth, just as in the winter formation of rings in trees. That is to say, the particular character of the regeneration is not transferred to the progeny, but a locally increased intensity of growth is transferred. In unretouched photographs of two young Ciona attached by their stolons to the scratched glass of an aquarium, the upper specimen is clearly seen to be contracted; the lower is at rest and shows its monstrously long siphons in full extension. They were already there at birth, for it was bred from parents the siphons of which had become elongated by repeated amputation and growth.

In those animals with artificially lengthened siphons we can, furthermore, combine with the amputation at the front end another amputation at the hinder end. At the hinder end—in the coils of the intestine

—lies the generative organ, an hermaphrodite gland. We remove the whole of this part of the body and leave the front part to regenerate and to reproduce a new generative organ; that is, *new germ plasm is formed from somatic tissue.* It has been established already in several species of animals and plants that Weismann's "continuity of germ plasm" is not obligatory but, at most, a facultative continuity. The long-siphon Ascidians with regenerated germ plasm give birth to progeny also long-siphoned. In this way the most familiar objection brought against the inheritance of acquired characters—the claim that there is a direct influence on the germ plasm—is, I think, definitely removed. The local character of the operation in cutting off the siphons renders this chief objection almost inapplicable. We might, however, still argue that physical influence still obtains; that while I am cutting the siphons at the head, a direct physical reaction is taking place on the germ plasm. In this case there would already be established that tendency which would give rise to an apparent inheritance in the progeny.

But now we cut away all the generative organ, with all its germ cells and its active and latent tendencies. We await the growth of a new generative organ. The regeneration takes place at a time when there are no further disturbances influencing the body. Nevertheless, the growth to which it gives rise is still affected. The change therefore cannot have been lying preformed in the original germ plasm. It can have come ultimately from nowhere but from the changed body.

The present circumstances are scarcely favourable for the furtherance of these researches in heredity in my impoverished country. During the War experimental animals, the pedigrees of which were known and had been followed for the previous fifteen years, were lost. I am no longer young enough to repeat for another fifteen years or more the experiments, with the results of which I have been long familiar, before I attempt to break new ground. The necessities of life have almost compelled me to abandon all hope of pursuing ever again my proper work—the work of experimental research. I hope and wish with all my heart that this hospitable land may offer opportunity to many workers to test what has already been achieved and to bring to a satisfactory conclusion what has been begun.

The Earth's Electric and Magnetic Fields.[1]

By Prof. W. F. G. Swann, University of Minnesota.

I.

Quite apart from those more spectacular manifestations of atmospheric electric phenomena associated with the thunderstorm, we have to recognise the following facts, as pertaining to the ordinary quiet day:

(1) The earth is charged negatively to such an extent as to give rise to a vertical potential gradient which amounts to about 150 volts per metre at the surface of the earth, and goes through fairly regular variations throughout the day and throughout the year, variations amounting to 50 per cent. or more of its total value.

(2) The potential gradient diminishes with altitude until its value at 10 kilometres is practically negligible compared with that at the earth's surface, a result which is brought about by the existence, in the atmosphere, of a positive charge, the total amount of which below the altitude 10 kilometres is practically equal to the negative charge on the earth's surface.

(3) The atmosphere is a conductor of electricity. The conductivity near the earth's surface is so small that a column of the air one inch long offers as much resistance to the flow of the electric current as would a copper cable of equal cross section extending to the star Arcturus and back twenty times over.

(4) In spite of the smallness of the conductivity of the atmosphere at the earth's surface, its amount is nevertheless sufficient to ensure that 90 per cent. of the earth's charge would disappear in ten minutes if there were no means of replenishing the loss.

(5) The conductivity increases with altitude at such a rate that its value at an altitude of 10 kilometres is about fifty times that at the earth's surface, and there is indirect evidence to substantiate the belief that at altitudes of the order of 100 kilometres it may attain a value more than 10^{11} times that at the earth's surface. Such a conductivity would cause the upper atmosphere to act, practically, as a perfect conductor in its relation to phenomena in the lower atmosphere.

(6) There is some evidence for and some against the view that our atmosphere is traversed by a radiation of cosmical origin, and of penetrating power ten times, or more, that of the gamma rays of radium.

A potent factor contributing to the conductivity of the atmosphere is the radioactive material in the air and soil. There are, on the average, about 1·5 molecules of radium emanation per c.c. of the atmosphere over land, yet this small amount is sufficient to contribute very appreciably to the ionisation there. On the basis of the known amounts of radium and thorium emanations in the atmosphere, and of radioactive materials in the soil, we could account fairly well for the ionisation of the lower atmosphere. The conductivity of the air over the great oceans is, however, practically as great as it is over land, and is very much greater than can be accounted for by the radioactive materials, which are negligible in amount in the ocean and in the air over it. The assumption of a penetrating radiation would provide a cause for the ionisation known to exist over the sea. If, however, we are unwilling to admit the existence of such a radiation, the ionisation over the ocean remains to some extent a mystery, and may have to be attributed to a small spontaneous ionisation of the gas.

The great problem of atmospheric electricity is, of course, the explanation of the maintenance of the earth's charge. The replenishment to be accounted for is small, amounting to only 1000 amperes for the

[1] Portions of a lecture on "Unsolved Problems of Cosmical Physics," delivered before the Franklin Institute on December 20, and published in full in the Journal of the Franklin Institute.

whole earth. As regards the positive charge in the atmosphere, there is little difficulty provided that we can account for the maintenance of the negative charge on the earth. For, even though a theory which accounted for the latter did not immediately imply the former, the known fact of the increase of atmospheric conductivity with altitude, combined with the law of continuity of flow of the electric current, would be sufficient to bring the positive charge into evidence. One of the earliest theories of the earth's charge is due to C. T. R. Wilson, who supposed that the atmospheric ions would serve as nuclei for the precipitation of rain, and that the drops would form more readily upon the negative than upon the positive ions, with the result that rain would be, on the whole, negatively charged, and would thus constitute the replenishment of the loss by conduction. The difficulty confronting this theory lies in the fact that the conditions necessary for the precipitation of rain on ions to form drops of appreciable size, do not readily occur in the atmosphere, and in the still more potent fact that, so far as measurements go, 90 per cent. of the rain which falls is positively charged. Thus, while rainfall may constitute a factor in the replenishment of the earth's charge, it is not one which operates in the right direction to serve as the sole cause.

Another theory of replenishment, depending ultimately upon gravity for the separation of the charges in opposition to the electric field, is that due to Ebert. It constitutes a modification of an earlier theory due to Elster and Geitel. Ebert's theory invokes the fact that if an ionised gas be passed through a fine tube the negative ions diffuse to the walls of the tube more rapidly than do the positive ions. Ebert supposes that, during periods of fall in barometric pressure, the air in the pores of the soil, which is ionised on account of the radioactive material therein, becomes drawn out into the atmosphere, positively charged on account of its having deposited an excess of negative ions in the interstices of the soil. Rising currents of air are then invoked to explain the transference of the positive ions to appreciable altitudes, against the electrostatic attraction of the negative. This theory has been criticised on account of the insufficiency of the charging action resulting from the diffusional process, on account of the smallness of the upward convection current of positive electricity as measured experimentally, and on account of the fact that it may be shown to predict a diminution of potential gradient with altitude such as would result in the gradient itself being practically negligible at an altitude of a kilometre.

The precipitation theory, and the Ebert theory, are of a type in which the replenishing action takes place over a limited region of the earth's surface at any one time, in such a manner that the positive electricity which is the counterpart of the negative charge on the earth is to be found in this limited region of the atmosphere. Under such conditions, the negative charge will be held on the portion of the earth's surface which lies in the immediate vicinity of the positive, and the potential gradient will be confined to this region. A partial way out of this difficulty can be found, however, if we admit the existence of a highly conducting layer in the upper regions of our atmosphere. In this case, the charge separation sets up a potential difference between the layer and the earth, so that the potential gradient, which would otherwise be confined to the region of replenishment, is shared as it were by the earth as a whole. Thus, for example, calculation shows that if a charged cloud is to be found at an altitude h above the earth's surface, and if H is the altitude of the conducting layer, and R the radius of the earth, the hemisphere of the earth which is symmetrically remote from the charged cloud receives R/H times the number of tubes of force which it would receive in the absence of the layer, and h/H times the number which it would receive if the negative charge on the earth and the positive charge in the cloud were spread uniformly over the earth and atmosphere respectively. It may be remarked, moreover, that this action of the conducting layer provides a partial loophole for escape from the particular objection to the Ebert theory which is founded on the impossibility of the positive charge reaching an altitude of more than a kilometre or so. Even such a small separation in the region of replenishment would make its own contribution to the potential gradient at other places through the medium of the conducting layer. The contributions in these places would be of a perfectly normal type, the variation with altitude being determined only by the nature of the variation of conductivity with altitude, in such a manner as to keep the vertical conduction current density independent of altitude.

In 1904 G. C. Simpson proposed a tentative theory of the earth's charge, in which it was assumed that the sun emitted negative and positive corpuscles of high penetrating power. The former were supposed to pass right through our atmosphere and penetrate the earth, while the latter were caught in the atmosphere. Such a degree of penetration is very much greater than any we are familiar with in the laboratory, for the beta rays of highest energy investigated will pass through only about 10 metres of air.

We can account for the replenishment of the earth's charge if we suppose that the atmosphere emits high-speed negative corpuscles. The earth will then charge up on account of the corpuscles which come from the molecules of air lying within striking distance of it. Such a possibility was examined by the writer in 1915. So far as the replenishment of the charge is concerned, the average range of the corpuscles may be made as small as we please by supposing a sufficiently copious emission of corpuscles. It turns out, however, that appreciable values of the potential gradient become confined to altitudes comparable with the average range, so that for this reason a large range must be assumed. This difficulty is avoided in a somewhat similar theory suggested by the writer, and somewhat later, but quite independently, by von Schweidler. According to this theory, the emission of corpuscles from the atmosphere is caused by the penetrating radiation which, coming from above, and being of a very hard type, ejects the corpuscles almost completely in a downward direction. If we assume that only three corpuscles are emitted per c.c. per second, by the penetrating radiation, an average range of nine metres in air at atmospheric pressure is sufficient to account for the replenishment of the earth's charge.

Two main difficulties confront any corpuscular theory of the earth's charge. The first arises from the failure to detect any charging effect, as a result of the influx of corpuscles, in the case of a mass of insulated metal surrounded by a thin metal shield to protect it from the potential gradient. The second arises from the fact that, in so far as the replenishment of the earth's charge requires the entry of 1500 corpuscles per sq. cm. per second, and, a corpuscle moving with a velocity approximating that of light produces about 40 ions in each centimetre of its path, we should expect a rate of production of 60,000 ions per c.c. per second. Experiment reveals a rate of production of less than 10 ions per c.c. per second, and these are attributable, for the most part, to known causes.

As regards the former difficulty, experiments to detect the charging effect were made by the writer in 1915, and more recently by von Schweidler, without finding any such effect. Unless we assume corpuscular ranges so great that there is negligible absorption in the test body, this result opposes any theory which invokes corpuscles shot into the earth from regions outside our atmosphere, or from the atmosphere itself as a result of direct spontaneous disintegration. The experiment is not so much in conflict with theory in the case where the corpuscles are emitted by the penetrating radiation, however. If the penetrating radiation is sufficiently hard to pass through the test body without appreciable absorption, it can be shown that it will eject as many corpuscles from the lower side of the body as it injects on the upper side.

Serious as the difficulty concerned with the ionising action of the corpuscles seems at first sight, there is a natural way of avoiding it, providing that we assume the corpuscles to have velocities so closely approximating the velocity of light that their tubes of force become crowded very greatly towards the equatorial plane. In these circumstances, if a corpuscle [2] is to give even a small finite amount of energy to an electron in the process of ejecting it from an atom, it must give it in an infinitesimal time, and such a phenomenon would require the payment of an infinite tax in the form of energy radiated. A full consideration of the details of the action shows that the reaction on the electron, due to its radiation, is such that, for any ionisation potential of the atom, there is a velocity sufficiently near to that of light, such that a corpuscle having that velocity would be unable to produce any ionisation in the gas.

The ionisation potential of oxygen, which is less than that of nitrogen, is 15·5 volts, and on the classical theory of electrodynamics a corpuscle would fail to ionise oxygen or nitrogen for all velocities in excess of 200 metres per second below the velocity of light. It may be of interest to remark that, in order that an electron should strike down into our atmosphere in the vicinity of the equator and reach the earth's surface, without being bent back by the earth's magnetic field, it would have to possess a velocity nearer to that of light than the above value, so that the very fact that it could reach the earth would be sufficient to ensure that it would not ionise on the way. Moreover, as another illustration of the same principle, it may be remarked that the above value for the velocity lies between the two limits, 400 metres per second less than that of light, and 4 metres per second less than that of light, assigned by Birkeland as the limits between which the velocities of negative electrons from the sun must lie in order that they shall be capable of accounting for the aurora. Of course, failure to ionise would prevent corpuscles from functioning as regards the aurora, and the figures in question are only cited for their general interest. There are other reasons for believing that the aurora is not caused by negative electrons.

Once we assume these high energies for the corpuscles, they carry with them the possibility of very great penetration, as may be shown from a consideration of the circumstances which determine absorption in the atmosphere. This penetrating power is enhanced by the diminution of the power of the corpuscles to communicate energy to the electrons by which they pass. Thus, while, as regards the mere explanation of the earth's charge, we may avoid the assumption of long ranges, as in the theory which invokes the penetrating radiation to eject the corpuscles from the air, we find it necessary to postulate, for the corpuscles, velocities closely approximating the velocity of light, in order to explain the absence of ionisation, and this of itself implies long range as a consequence.

(*To be continued.*)

[2] The word "corpuscle" is merely used to distinguish the high-speed electron, the ionising powers of which are under discussion, from the electron in the atom.

The Royal Academy, 1923.

THE private view of this year's Exhibition of the Royal Academy took place on Friday, May 4. The juxtaposition of the Royal Society and the Royal Academy suggests something deeper than the accident of both being dependent upon the patronage of the wealthy and the hospitality of the State. On either side of the wall that separates the academies of art and science the work is alike also in this—the impulse of the worker is to represent and thereby to preserve the visions that he has seen, that others might have seen if they had been gifted with the insight that sees things hidden from the rest of the world by the blinding candour of Nature. One uses paint or clay, and the other the printing-press or the experimental table; and however dependent either may be on the smile of the wealthy or the favour of the potentate for the means to "carry on," the satisfaction of achievement in the effort to express what they alone have seen with the mind's eye redresses for either the adverse balance of many an account. A year's Proceedings of the Royal Society show what the fellows wish to hand on to posterity as expressing their searching into Nature: so the yearly exhibition at Burlington House represents the messages to which the artists of to-day have dedicated their power of insight.

Passing through the galleries for the first time one wonders what message the artist is trying to convey and whether he has succeeded. There can be little doubt that 200 (*Still Life*, by Meredith Frampton) aspired to give the impression of china ducks and flowers, and has succeeded; and the same may be said of an impressive study of huge Atlantic waves close at hand, with a tiny ship in the background, 558 (*Henry Hudson, 1607*, by Norman Wilkinson); but what the message is in 15 (*Little Dancer*, by Glyn Philpot) is less obvious: it is perhaps the beauty of gradations of subdued colour. So also the piece by the same artist, 170 (*Penelope*), and 34 (*Youth*, by F. Cayley Robinson), and in a drab monotonous way 155 (*Hayling Island*, by Oliver Hall). There are others, on the contrary, who use vigorous contrasts instead of gentle gradations. Such are 36 (*Rocks, Tregiffran*, by Robert M. Hughes), 53 (*Sennen Beach*, by Laura Knight), and 234 (*Wiltshire Downs*, by Edward Buttar), and even more impressive as an appeal to the sense of beauty of colour, saffron with blue shadows and pink sky, 151 (*An Autumn Evening in the Western Highlands*, by Adrian Stokes), and 264 (*Seagulls Nesting*, by Charles Simpson), a vision of the colours of spring. Not always satisfying are these schemes; 366 (*Sons of the Sea: Polperro, Cornwall*, by John R. Reid) makes one think of the artist's colourman rather than Nature's beauty.

One of the striking features of the pictures by the well-known artists is the sensation of vivid illumination. Marked discontinuities of light and shade give the effect, obviously desired, in 25 (*Ariñez on the Battlefield of Vitoria, Spain*, by James P. Beadle), 72 (*Glebe Place, Chelsea, 1922*, by George Henry), 175 (*Lovers of the Sun*, by H. S. Tuke), 278 (*Market Jew: Thursday*, by Stanhope A. Forbes), and 174 (*An Italian Lemon Garden*, by H. H. La Thangue): in the last the discontinuities are perhaps too strong for real pleasure. There is a wonderful sense of luminosity from discontinuity of colour alone without very marked shadows in another picture by the same artist, *The Mill Stream* (64), and also in 336 (*The Finish*, by Harry Fidler).

A juxtaposition of colours that one may call iridescence is artfully used to convey the sensation of local luminosity in 126 (*Golden Summer, Cornish Coast*, by Julius Olsson), and 191 (*Surf-bound Shore*, by the same artist), and 565 (*The Coastwise Lights*, by Harry Van der Weyden); also, but less successfully, for the illumination of the misty atmosphere of a setting sun of vast dimensions in 379 (*The Fading Day*, by Fred Hall). Some artists boldly paint a parti-coloured background and let the spectator regard it as sky if he please. That is noticeable in the colour scheme of 19 (*The Trojan Women*, by Charles Ricketts), in 226 (*The Sons of Ellis Hajim, Esq.*, by Charles Sims), and 229 (*Brood Mares and Foals at Southcourt Stud*, by Alfred J. Munnings).

As a fellow-student of Nature one cannot but feel that the sky must be a very exasperating part of an artist's subject unless it is all blue, or all grey, or all pink. When there are clouds with definite shape and movement the representation of Nature's varying mood is very difficult. The natural sky, even when it is most complex, is not chaotic: it has lines and touches that suggest order, a horizontal alignment, a characteristic shape, the detail of an outline, but so subtle and so transient that, while the student is meditating its features, they are gone. Apparently only the more noted artists challenge the heavens with a presentation of this subtle order in disorder, and not with complete success. 137 (*Tilty Church*, by George Clausen) shows clouds of easily recognised shape, but lacking the characteristic detail of outline. The most successful skies succeed by evading the real problem. The beautiful picture of *The Port of London* (213), looked at from above, by W. L. Wyllie, makes an atmosphere of native smoke and excuses the sky. Almost the same artifice is used in another picture by the same artist, *A Storm is Coming* (217). Details are also avoided by a general "all-overishness" in 162 (*The Lowlands of Holland*), 310 (*In from the Sea*), both by Robert W. Allan, and 370 (*A Grey Sea*, by the Hon. Duff Tollemache), and in a beautiful Scottish snow picture (124) by Joseph Farquharson. The challenge is evaded in 236 (*Summer Morning, St. Ives*, by Charlton Fortune) by filling up the sky with seagulls; but it is deliberately taken up by Arnesby Brown in quite a number of pictures—3 (*September*), 79 (*The Swing Bridge*), 130 (*The Waiting Harvest*), 148 (*The Watch Tower*): the disorder is there patent, but the whisperings of order in a disordered sky are missing. No more successful in this respect are 178 (*A May Morning at Southcourt*, by A. J. Munnings), 203 (*The Mountain Stream*, by Lewis T. Gibb), 335 (*Dover and Castle from the North*, by Frank P. Freyburg).

There is a peculiarity about natural skies; without any effort one is conscious that one is watching either the plan of an extensive layer or the elevation or profile of individual clouds. It is only occasionally that one gets that sort of satisfaction out of a picture. It is very nearly complete in 207 ("*If the clouds be full of rain, they empty themselves upon the earth*," by Frank Walton), in a picture by R. Vicat Cole, and in 484 (*Tintagel*, by Algernon Talmage). One misses it in 199 (*The Blue Pool*, by the late Mark Fisher), and in 259 (*Before the Ruined Abbey*, by Sydney Lee). It has often been remarked that the Greeks and Romans had no names for the forms of clouds which we have learned to recognise so easily. The exhibition suggests that the reason lies very deeply set.

As one leaves the galleries the questions as to what message the artists meant to convey and whether they have succeeded recur. Among the pictures most satisfying in answering both questions at first sight we may name 47 (*The White Sands of Scilly*, by Julius Olsson), 124 ("*Some gleams of sunshine mid renewing storms*," by Joseph Farquharson), already mentioned, 333 (*Green-clad Hills, Lake of Annecy*, by Terrick Williams), and 636 (*Winter Evening, Engelthal*, by Adrian P. Allinson).

Judging from experience outside, one might have been afraid that the Academy of 1923 with its multitude of portraits would have been a nightmare of horn-rimmed spectacles: it is not so. There is only one specimen, *Portrait of the Painter*, by the late Sir J. J. Shannon. The pervading influence of the War has also passed away except in the sculpture rooms and in the satiric picture by Sir William Orpen.

Scientific worthies are not very conspicuous in the collection. There is a bronze bust of the late Dr. Ludwig Mond, and one of the late Sir James Dewar (by G. D. Macdougald); also a marble bust of Sir J. J. Thomson, by F. Derwent Wood, as well as the portrait by Fiddes Watt.

Current Topics and Events.

THE growth of our knowledge of stellar physics during the present century has been surprisingly rapid. It has arisen by combining the results of researches of most varied kinds. The older astronomy of position has afforded the data for the positions, distances, and motions of the stars, which were a preliminary to the establishment of the theory of giant and dwarf stars, and also to the detection of the possibility of finding parallaxes by the spectroscope, and so distinguishing the giants from the dwarfs. In another field, the discovery of radium, and radio-activity generally, has revolutionised ideas on the nature of the atom, and led to the detection of analogies between chemistry and dynamics. Prof. Eddington, whose lecture on "The Interior of a Star," delivered at the Royal Institution on February 23, is printed as a supplement to the present issue, is one of the leading pioneers in this field. His earliest astronomical work was concerned with stellar distances and proper motions; but he has recently worked more on the physical side. Prof. Eddington was one of the first to point out the importance of light pressure in causing the distension of giant stars, and also to suggest that the immense duration of their output of energy is explicable by their drawing on the store of energy in the atom. This was first offered as a tentative explanation, but Prof. Eddington now makes it definitely. A remarkable confirmation of the correctness of the accepted views on stellar physics was afforded by the close agreement of the diameter of Betelgeuse, as given by the interferometer, with that deduced from the study of the distribution of energy in the spectrum, which led to a value of the temperature and surface brightness.

THE approaching visit to London of Prof. H. A. Lorentz, of the Teyler Institute at Haarlem, and the University of Leyden, is being eagerly awaited by physicists. Prof. Lorentz is the *doyen* of mathematical physicists. In 1880 he developed from electromagnetic theory a connexion between refractive index and density (known by his name), which holds good through great ranges of density, though requiring a small correction for extreme states as recent experiments on carbon dioxide have demonstrated. At the present time, Prof. Lorentz is acclaimed in the main for the fundamental work he has done in connexion with the electromagnetics of moving bodies. In this work he has served as an intermediary between the old electromagnetics and the modern doctrine of relativity. Einstein's results agree mainly (though not exactly) with those which Prof. Lorentz had obtained, "the chief difference being that Einstein simply postulates what I have deduced with some difficulty and not altogether satisfactorily from the fundamental equations of the electromagnetic field" (Lorentz). Prof. Lorentz contributed to the explanation of the magneto optic phenomena discovered by Zeeman and others. "I may refer in the first place to the intensely stimulating influence of H. A. Lorentz's theories. It is difficult to find adequate words to express my indebtedness to Lorentz's personal inspiration and to his theories" (Zeeman). Prof. Lorentz visited the British Association at the Birmingham meeting in 1913, and made important and guarded contributions to the discussion on radiation and the quantum theory. His first lecture in London is at 5.30 P.M. on May 17, at University College, Gower Street. Admission is free, without ticket. Three other lectures by Prof. Lorentz, at the same place, have been arranged to be delivered in the early part of June. He is also lecturing at Cambridge (Reid Lecture), at Manchester, and elsewhere.

SHORTLY after the death of Dr. W. H. R. Rivers in June last, it was suggested that the eminence of his services to science should be recognised by some form of memorial; but it was not found possible to take any further steps at the time. A few of Dr. Rivers's friends have now formed a small committee with the view of giving the proposal practical effect. Among those serving are: Sir Charles Sherrington, Sir William Ridgeway, Sir Humphry Rolleston, Sir James Frazer, Dr. Henry Head, Dr. A. C. Haddon, Mr. Henry Balfour, Prof. G. Elliot Smith, Dr. C. S. Myers, and Prof. C. G. Seligman. This committee has now issued an appeal for subscriptions to a fund of which Dr. L. E. Shore of St. John's College, Cambridge, acts as treasurer. The fund will be devoted to the promotion of those sciences in which Dr. Rivers was particularly interested, but the decision as to the manner in which this will be effected will rest with the subscribers, of whom a meeting will be summoned in due course. It is permissible to express a hope that the committee and subscribers will decide to devote the fund to some object which it is known that Dr. Rivers had closely at heart, such as, for example, the assistance of the publication of scientific memoirs for which ordinary scientific or commercial channels are not available on the ground of cost.

DURING the summer of 1922 a member of the Cambridge Natural History Society was in Vienna and made the acquaintance of Dr. Kammerer, who appeared to be willing to visit England, should an opportunity occur. After further correspondence with Dr. Kammerer, the matter was placed before the council of the society in March last, and it was then decided that Dr. Kammerer should be invited in the name of the society to give a lecture at Cambridge. The invitation was accepted by Dr. Kammerer, and the lecture is published elsewhere in this issue. All expenses of the journey were provided for by contributions from members of the society, and on April 25 Dr. Kammerer arrived in England, and has since been the guest of the society.

THE Croonian lecture of the Royal Society will be delivered on June 21 by Dr. F. F. Blackman, who will take as the title of his lecture "Plant Respiration as a Catalytic Process."

DR. JOHN PALIBIN, director of the Botanical Garden at Batoum, has accepted the post of assistant to the museum director in the principal botanical garden of Petrograd, where he hopes to have more opportunity for those researches in palæobotany in which he has won distinction.

AT University College, London, on Friday, May 11, the chairman of the College Committee (the Rt. Hon. the Viscount Chelmsford) is to unveil a tablet commemorating the munificent gifts for the new chemistry building made by Sir Ralph Forster, Bt.

A LOAN collection of pictures painted by Miss Edith Cheesman in Mesopotamia will be on view in the North Gallery of the Imperial Institute from May 7 from 10 A.M. to 5 P.M. daily, except Sundays. Admission is free. The pictures, which are in oils and water-colours, are illustrative of life and scenery in Mesopotamia and include both portraits and landscapes.

A MASTER is required for service on the Colonial Government ship *Discovery*, whose duties will be mainly research in whaling in the Antarctic. Full information and forms of application are obtainable, by letter, from the Secretary, *Discovery* Committee, Colonial Office, S.W.1. No special form is necessary for candidates abroad. The latest day for the receipt of applications is May 31.

THE Air Ministry announces that the Royal Air Force pageant, which was instituted in 1920, will take place on Saturday, June 30, at the London Aerodrome, Hendon, by arrangement with the Grahame White Company. It is hoped that the King will be present. The pageant now affords the general public an annual opportunity of observing developments both on the flying and technical sides of the work of the Royal Air Force.

THE Faraday Society will hold a general discussion on "The Physical Chemistry of the Photographic Process" on Monday, May 28, in the Hall of the Institution of Electrical Engineers, Victoria Embankment, W.C.2. Prof. W. D. Bancroft, of Cornell University, will open the proceedings at 3 P.M. with an introductory address on "The Theory of Photography." This will be followed by detailed consideration of the subject, subdivided as follows:—(1) "The Physical Chemistry of the Vehicle and of the Emulsion"; (2) "Reactions in the Plate during Exposure"; (3) "Development and Characteristics of the Developed Plate"; (4) "Adsorption Reactions in Photographic Films." Each section will be introduced by a preliminary address and followed by general discussion. Among those who will read papers are Dr. T. Slater Price, Dr. F. C. Toy, Mr. Olaf Bloch, Mr. T. Thorne Baker, M. Clerc, Prof. Luther, and Prof. Goldberg. Several communications will be made from Mr. S. E. Sheppard and other members of the staff of the Eastman Kodak Company, and papers are also expected from Dr. Chr. Winther, Dr. Lüppo-Cramer, and Prof. L. Plotnikov. Between the afternoon and evening sessions a complimentary dinner will be given at the Hotel Cecil to Prof. Bancroft and the other guests. Members of the Chemical Society are invited to attend this meeting. Full particulars may be obtained from the Secretary of the Faraday Society, 10 Essex Street, London, W.C.2.

THE New York correspondent of the *Times* states that Lieuts. Macready and Kelly completed a non-stop aeroplane flight across the United States from New York to San Diego on May 3. The distance traversed was approximately 2600 miles and the time is given as 26 hours 50 minutes 38⅗ seconds.

M. GEORGES BARBOT crossed and recrossed the English Channel on May 6 in a small monoplane fitted with a two-cylinder 15 h.p. engine, thus winning a prize of 25,000 francs offered by *Le Matin* for the complete journey. M. Barbot left the aerodrome at St. Inglevert at 6.20 P.M. and arrived at Lympne at 7.21 P.M.; the return journey was commenced at 8.1 P.M., and the aeroplane arrived over St. Inglevert aerodrome at 8.45 P.M.

WE learn from *La Geographie* for February that a wireless station has been erected at Mygbugten, on the east coast of Greenland, in lat. 73° 30′ N., and has been functioning since last October. The station is due to the enterprise of the Norwegian Meteorological Service. Weather reports are sent by wireless telegraphy to the station on Jan Mayen, and thence to Christiania. The Greenland station and those on Jan Mayen, Iceland, Bear Island, and Spitsbergen almost encircle the Greenland sea.

AT the Hull meeting of the British Association in September last there was a discussion in the Section of Anthropology upon the genuineness of some bone implements known as the "Holderness Harpoons" (see NATURE, October 7, p. 481, and December 2, p. 735). Mr. O. J. R. Howarth, secretary of the Association, writes to say that though several references have recently appeared to a committee of the British Association as having pronounced upon the question, no committee was appointed by the Association or its anthropological section to investigate this subject.

AT the annual general meeting of the Manchester Literary and Philosophical Society held on April 24, the following officers and members of council were elected: *President*, Prof. H. B. Dixon; *Vice-Presidents*, Mr. T. A. Coward, Prof. A. Lapworth, Mr. C. E. Stromeyer, and Prof. F. E. Weiss; *Secretaries*, Dr. H. F. Coward and Prof. T. H. Pear; *Treasurer*, Mr. R. H. Clayton; *Librarians*, Mr. C. L. Barnes and Dr. W. Robinson; *Curator*, Mr. W. W. Haldane Gee; *Other Members of the Council*, Prof. W. L. Bragg, Prof. S. Chapman, Rev. A. L. Cortie, S.J., Prof. S. J. Hickson, Mr. F. Jones, Laura Start, Mr. R. L. Taylor, Mr. W. Thomson, and Mr. L. E. Vlies.

THE council of the Institution of Civil Engineers has made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1922–1923: Telford medals to Mr. H. W. H. Richards (London) and Mr. E. O. Forster Brown (London); a George Stephenson medal to Mr. Asa Binns (London); a Watt medal to Mr. A. B. Buckley, jun. (Winchester); Telford premiums to

Mr. W. A. Fraser (Edinburgh), Mr. S. L. Rothery (Calexico, U.S.A.), Mr. Mark Randall (Johannesburg), and Mr. D. E. Lloyd-Davies (Cape Town); an Indian premium to Mr. D. H. Remfrey (Calcutta); a Manby premium to Mr. F. M. G. Du-Plat-Taylor (London); and a Crampton prize to Mr. F. W. Jameson (Kimberley).

An appreciation of the scientific work and discoveries by Sir James Dewar was broadcasted by Prof. J. A. Fleming on May 4 from the London station 2 LO. Prof. Fleming first referred to Sir James Dewar's work on the liquefaction of air, oxygen, and hydrogen, and the invention of the silvered vacuum vessel for storing these liquids. Closely related with this work was the discovery of the use of charcoal cooled in liquid air for the production of high vacua. Sir James Dewar also made important discoveries in spectroscopy and in connexion with the production of physiological electric currents by the action of light. His work in chemistry contributed to the invention of cordite, while soap films and their behaviour in dust-free air occupied his attention until the last day of his working life. Sir James Dewar's investigations were undertaken in the first instance purely out of a disinterested desire to increase scientific knowledge, but the results have in nearly every case produced numerous beneficial and practical applications.

At the annual meeting of the members of the Royal Institution held on May 1, the following officers were elected: *President*, The Duke of Northumberland; *Treasurer*, Sir James Crichton-Browne; *Secretary*, Sir Arthur Keith; *Managers*, Mr. S. G. Brown, Dr. J. M. Bruce, Sir Dugald Clerk, Prof. J. A. Fleming, Sir Richard Glazebrook, Earl Iveagh, Sir Alexander C. Mackenzie, Mr. Robert Mond, Sir Edward Pollock, Prof. A. W. Porter, Lord Rothschild, Sir David Salomons, Mr. W. Stone, Sir Alfred Yarrow, The Right Hon. Lord Justice Younger; *Visitors*, Sir Harry Baldwin, Prof. William A. Bone, Mr. A. Carpmael, Dr. E. Clarke, Mr. E. Dent, Dr. T. W. Dewar, Mr. G. H. Griffin, Mr. W. E. Lawson Johnston, Col. F. K. McClean, Sir Malcolm Morris, Dr. W. Rushton Parker, Mr. W. Peacock, Major C. E. S. Phillips, Mr. H. M. Ross, and Mr. S. Skinner. Sir J. J. Thomson has been elected honorary professor of natural philosophy, and Sir Ernest Rutherford professor of natural philosophy. The Duke of Northumberland has nominated the following gentlemen as vice-presidents for the ensuing year: Dr. Mitchell Bruce, Lord Iveagh, Sir Edward Pollock, Lord Rothschild, Sir Alfred Yarrow, The Right Hon. Lord Justice Younger, Sir James Crichton-Browne (Treasurer), and Sir Arthur Keith (Secretary).

A catalogue (No. 259) of books in all branches of chemical science and technology, including the textile industries and agriculture, has just been issued by Mr. W. Bryce, 54 Lothian Street, Edinburgh. It should be very useful for reference. The same bookseller also issues a short list of second-hand books in technology, the classics and general literature, surplus government stock, which are offered at greatly reduced prices.

Our Astronomical Column.

The April Meteor Shower.—Mr. W. F. Denning writes: "This event occurred on the nights of April 21-23. The weather, however, was not very favourable on the night of expected maximum, April 21, and few meteors could be seen owing to clouds. The special display of Lyrids supplied nearly half the total number of meteors observed on the three nights, and the radiant point was in the usual position at about $272^{\circ}+33^{\circ}$.

"It sometimes happens that when the Lyrids are not very abundant, meteors generally are very scarce, and this appears to have been the case on the recent occasion, the hourly rate of apparition being only 3.

"There are a considerable number of radiant points in activity at this period of the year, but the great majority of them are extremely feeble, and an observer must watch the sky for a long period before they may be recognised. Two meteors seen on April 20 last were each recorded at two stations and the paths indicate radiants at $271^{\circ}+35^{\circ}$ and $310^{\circ}+59^{\circ}$."

Temperature and Density of the Upper Atmosphere deduced from Meteors.—Prof. F. A. Lindemann and Mr. C. M. Dobson contribute a paper on this subject to Proc. Roy. Soc. (Series A, vol. 102, No. A 717). They deal with the large number of doubly observed meteors discussed by Mr. Denning, and give reasoning which leads to the conclusion that during most, if not all, of the meteor's visible track, the molecules of air impinge on a layer of compressed air in front of the meteor. Evaporation goes on from the surface of the meteor, and in general the meteor is wholly consumed long before reaching the ground. Long-enduring trains are explained as the slow recombination of ions separated by the energy of the meteor. The meteors are shown to be very small particles. One as bright as a star of the first magnitude would be 1 mm. in diameter. One as bright as the moon would be 2·5 cm. in diameter (mass 62 gm.). Discussion of the observed phenomena on these lines leads to determinations of the temperature and density of the air at different heights. It is concluded that the isothermal layer, already discovered by *ballon sondes* to extend to a height of 25 km., goes on up to 50 km.; but that above that height the temperature again rises to 280° or 300° abs. The density of the air at 100 km. (about the lower auroral limit) comes out 100 times that previously assumed; it is suggested that it may not be hopeless to reproduce the auroral spectrum in the laboratory, if the corresponding density is 10^{-8} instead of 10^{-10}.

It is suggested in explanation of the high temperature of the upper air that it is largely composed of ozone, which is heated by the infra-red radiations from the earth.

Prof. Lindemann describes in Mon. Not. R.A.S. for January a method which he is using of photographing meteors simultaneously at stations some distance apart, so as to get their height very accurately in order to apply a more rigorous check to his conclusions.

Research Items.

A Roman Fortified House near Cardiff.—In the Journal of Roman Studies (vol. xi. Part i), Mr. R. E. M. Wheeler gives an elaborate account of a fortified Roman villa, about two miles west of the west bank of the river Ely, at the point where that river, though still tidal, first becomes fordable. He concludes that about A.D. 300 this work fell into line with the general defensive and offensive activities of the period. At a time when Romano-British towns seem to have built or strengthened their walls as the Welsh tribesmen did, it is not unnatural that a private householder should have followed the same example on a smaller scale. It is indeed rather matter for remark that other examples of domestic fortification in the late Roman period have been so rarely observed or recorded. The closest analogy is perhaps the partially excavated house and baths within the Castle Dykes near Ripon.

An Old-World Cubit in America.—In *Ancient Egypt*, Part iv. 1922, Prof. W. M. Flinders Petrie directs attention to excavations made by the School of American Research at Santa Fé, New Mexico, where the measurements of buildings indicate a unit of 20·7 inches. This figure accords exactly to the well-known Egyptian cubit: 20·62 in the best early examples, 20·65 in later cubit rods, 20·76 on the Roman Nilometers. Babylonia had a rather longer type, 20·88 in. for the cubit of Gudea's plotting scales, and this was also the standard of Asia Minor, 20·6 to 20·9, with a mean of all of 20·63 in. "How could this reach New Mexico? It was evidently Asiatic. We have evidence from weights of an Asiatic diffusion of a Babylonian original over India, China, and Etruria. If the cubit similarly passed to China, it might thence reach North America. It has been already pointed out how the cross at Palenque (Southern Mexico) was in its detail of ornament derived from Italian crosses of about the eighth century, probably carried to China by the Nestorian mission. By the same route the Asiatic cubit may have passed over to the New World at some earlier period."

Marriage Customs in Medieval India.—In a paper published in the last issue of the Bulletin of the School of Oriental Studies, Sir G. Grierson directs attention to an epic still recited in Northern India describing the war between the Rajputs of Bundelkhand and Delhi. When a Raja had a marriageable daughter he used to send a challenge to neighbouring Rajas, who attacked him, and the contest for the bride was accompanied by serious loss of life on both sides. No exact parallel to this custom has been traced, and it looks as if the bard had exaggerated the details of the mock fight which occurs on the occasion of a wedding. The view that this is a survival of marriage by capture is now generally abandoned, and anthropologists are disposed to believe that the mock fight is a symbol of a contest between the powers of good and evil. The final victory of the good spirits is carefully arranged beforehand, and thus the fertility and happiness of the union is assured.

Submarine Weathering of Rock-material.—K. Hummel of Gieszen (*Geologische Rundschau*, vol. 13, p. 40, 1922) gives the name "halmyrolysis" to the processes of decay and reconstruction, akin to weathering, that go on in rock-material on the floor of seas and oceans. He gives special attention to the origin of glauconite, and attributes its absence from fresh-water deposits to the facts that the salts in sea-water are essential to the reactions that build it up, and that certain marine bacteria also play a part. The organic matter, the humic acid, and the energy of oxidation on sea-floors are not sufficiently different from those in lakes to account, as others have suggested, for the absence of glauconite from fresh waters. We may hope that the author will expand his views (p. 102) on phosphatisation on the sea-floor, which he regards as beginning with the absorption of phosphorus by gels consisting of calcium carbonate. The colloidal character of the material for which A. F. Rogers has recently revived the name of "collophane" (see Nature, vol. 110, p. 292), might thus be an inheritance from previous colloidal calcium carbonate; but this would not account for the widely spread "halmyrolysis" of marine oozes and limestones without loss of the intimate structures of their shelly constituents, which were deposited as crystalline material.

Tertiary Brachiopoda of Japan.—Ichirô Hayasaka, whose papers on the Palæozoic Brachiopoda of Eastern Asia and the Permian Brachiopoda of Japan we have already had occasion to refer to (Nature, July 29, p. 161, and December 2, p. 749, 1922), has now dealt with the Tertiary Brachiopoda of Japan (Science Reports, Tôhoku Imp. Univ., Sendai, Second Series (Geology), vol. ii., No. 2). While the waters of the Japanese Islands are notoriously rich in these forms, no fewer than thirty-seven species of "lamp-shells" being recorded therefrom, only thirteen species and five varieties figure in the present monograph, one species and four varieties being believed to be new. Of the eighteen forms, seven are only known fossil, seven are found living in Japanese waters, while the remainder now inhabit distant regions. The occurrence in Japan of *Terebratulina septentrionalis* in the fossil state, indeed, seems to be the first recorded instance, and that, since it is to-day an Atlantic form, is the more remarkable. In an appendix one other species and another variety are recorded as coming from the Pleistocene. These last are apparently additional to the three previously recorded from beds of that age near Tôkyô in 1906.

The Inner Structure of Alloys.—The thirteenth annual May lecture of the Institute of Metals was delivered on Wednesday, May 2, by Dr. W. Rosenhain. Referring to the great accumulation of facts in regard to the properties and microstructure of alloys which have been forthcoming in recent years, Dr. Rosenhain considers that it is most desirable that there should be found a key to this maze of knowledge in the form of a general theory that will link together the mass of facts into a homogeneous whole. Such a theory is put forward, based upon the intimate knowledge of crystal structure acquired by X-rays analysis. The crystal structures found in pure metals are modified in the case of alloys, particularly in those called solid solutions, where a second kind of atom enters into the structure of the crystal and produces in it certain minute changes. Especially important is the connexion between the minute distortion of crystal structure which occurs in alloys and the behaviour of alloys on melting and freezing, while such phenomena as plasticity, diffusion, and others fall easily into line with the same type of explanation. This new theory of alloy structure is said to afford a ready explanation of the electrical properties of metals and alloys and the changes of those properties when the metal is heated or cooled, and cover the phenomena of super-conductivity found in many metals when cooled nearly to the absolute zero of temperature.

WEATHER RESEARCH ON THE KERMADEC ISLANDS.—The *New Zealand Journal of Science and Technology*, vol. v. No. 5, contains an article by Mr. D. C. Bates, director of the Dominion Meteorological Office, Wellington, on the above. The chief feature of the article is an effort to stimulate the acquiring of Sunday Island, the largest of the Kermadec Group, for a meteorological station, which it is maintained would improve the weather forecasting for New Zealand. It is shown that cyclonic disturbances commonly influence the weather at Sunday Island a couple of days or so before being felt in New Zealand or the adjacent waters. The island was first discovered in 1788 and was partially frequented by settlers in 1837, but calamities which have occurred suggest the question whether it is worth while occupying apart from weather reporting. The island is apparently of volcanic origin, and earthquakes occur about once a month. It is mountainous, with few flat surfaces; water is not easily procurable, and it is out of the track of vessels. The rainfall is said to be by no means deficient. Meteorological observations taken for nine months in 1908 show a total rainfall of 66·26 in. during the period; the heaviest monthly fall was 11·30 in. during April, the least, 3·91 in. during September. The highest temperature in the shade was 85° F. in February, the lowest 46° F. in August. Easterly winds predominate from February to May, and westerly winds from June to October. No observations are available for November, December, and January.

THE DELAY OF VISUAL PERCEPTION.—The issue of the *Optician and Scientific Instrument Maker* for April 20 contains an article by Mr. F. G. Smith which summarises the recent work of Prof. Pülfrich on the effect of brightness on the time which elapses between the formation of an image on the retina and its perception by the observer. If an object moving across the line of vision from left to right is viewed with the right eye direct and with the left through a smoked glass to diminish the brightness of the image formed on the left retina, there is a delay in perception in the case of each eye, but the delay for the left eye exceeds that for the right, and the body appears to the left of and behind the actual position it occupies. If the object is moving from right to left it appears for the same reason to the right and in front of the actual position. If it moves alternately to right and left it appears to describe a circular motion about its mean position. The experiment is easily done with a fixed and a moving pencil, and it is rather remarkable that the phenomenon has not been observed previously.

BRITISH SURVEYING INSTRUMENTS.—Several recent improvements in the design and construction of British-made surveying instruments are detailed and illustrated in a paper by W. H. Connell in the Proceedings of the South Wales Institute of Engineers, vol. xxxix. No. 1, March 15, 1923, which has been reprinted in pamphlet form by Messrs. Cooke, Troughton and Simms, Ltd., Buckingham Works, York. Modern manufacturing methods involving the extensive use of jigs render possible the attainment of great accuracy and uniform production of the parts of instruments. The use of new and improved alloys has diminished the wear of moving parts, and thus instruments retain their adjustments for longer periods. Changes in design have led to the elimination of many adjustments, only one being necessary or provided in many modern levels, namely, that for securing parallelism between the line of sight and the tangent to the curve of the bubble tube. By the adoption of the internal focussing telescope collimation errors are almost entirely eliminated, and the use of accurately fitting removable cells permits of the graticules being cleaned or exchanged without disturbing the collimation adjustment. Changes have been introduced also with the view of saving time and labour in taking readings. For, example, the bubble, compass, and staff can all be read from the eye-end of the telescope without change of position on the part of the surveyor, and the focussing screw is easily accessible no matter what position the telescope may be in.

LITHIUM CARBIDE AND HYDRIDE.—In the *Comptes rendus* of the Paris Academy of Sciences for April 9 MM. A. Guntz and Benoit give an account of some properties of a mixture of lithium carbide and lithium hydride. This homogeneous mixture can be obtained either by heating metallic lithium in ethylene or by dissolving lithium carbide in fused lithium hydride. Submitted to electrolysis this fused mixture gives an abundant deposit of amorphous carbon. This may arise from a true electrolysis of the carbide or by a secondary reaction between hydrogen from the electrolysis of the hydride and the lithium carbide. From the results of their experiments the authors are inclined to regard the first view as the correct one, the lithium carbide being ionised into its elements in the hydride solution. The minimum electromotive force required to produce the carbon deposit is about 0·05 volt.

VULCANISATION OF RUBBER.—Mr. V. V. Byzov, in the Journal of the Russian Physical and Chemical Society, 1921, vol. 53, gives an account of work he has carried out on the vulcanisation of rubber. The researches indicate that the processes of hot and of cold vulcanisation are essentially the same, and are of extreme complexity. Vulcanised rubber consists of four components, which may exist in varying proportions in different samples of rubber. The first component is crystalline sulphur, which can be extracted from the rubber by boiling acetone. In a specimen of rubber containing 2·86 per cent of sulphur, 1·57 per cent was of this type. Most of the remaining sulphur is adsorbed in the rubber, and is in the amorphous plastic condition, this form of sulphur being insoluble in acetone. While plastic sulphur, under ordinary conditions, soon crystallises, in the fine state of division in which it occurs in rubber, conditions are perfect for supercooling, as each globule of sulphur is enclosed in a protective coat of colloidal material. To this plastic sulphur is ascribed the superior elasticity of vulcanised rubber. The rubber itself undergoes isomeric change to an insoluble form, from which a hydrochloride more stable than that obtained from ordinary rubber may be prepared, and the ozonide of which gives, on hydrolysis, not lævulinic aldehyde, as does that of natural rubber, but diacetyl propane. Whether this difference is due to a different degree of polymerisation of the isoprene molecules, or whether a transposition of the double linkages has occurred, it is not possible definitely to state. The fourth constituent of vulcanised rubber is a polymorph of isoprene disulphide $[C_{10}H_{16}S_2]_n$, but this is not as a rule present to any great extent. Thus vulcanisation of rubber is not a reversible process, and the problem of the recovery of pure rubber from an already vulcanised material, important in the waste rubber utilisation industry, appears to be an impossible one, as no means are known whereby the insoluble isomeride of rubber can be converted into the natural form.

The Forthcoming Pasteur Centenary Celebrations at Strasbourg.

WE have already announced that the Government of the French Republic has desired to commemorate this year the centenary of Louis Pasteur, and Strasbourg, where this illustrious savant commenced his scientific and university career, has been very fittingly chosen as the scene for the celebrations. Chief among these will be an international scientific exhibition—L'Exposition Internationale du Centenaire de Pasteur—which has been organised with the object of setting forth the fruits of Pasteur's work, not only in the domain of medicine but also in those of industry and agriculture. This exhibition will be officially opened on June 1 in the presence of the President of the French Republic, members of the French Government, and scientific delegates from all over the world. On the same day a monument erected to the honour of Pasteur in the Place de l'Université will be inaugurated, and a further permanent memorial is to take the form of a Museum of Hygiene. This will consist of a collection of exhibits illustrative of the various researches of Pasteur, and will constitute a history, in concrete form, of the early years of the science of microbiology.

The International Exhibition promises to be a most extensive and complete demonstration of the manifold results of Pasteur's work, both in pure and in applied science. It is to be organised in twelve groups, namely, microbiology, chemistry and chemical industry, collective hygiene, general hygiene, physical training, town hygiene, alimentary hygiene, food industries, refrigeration, agriculture, silks and sericulture, and finally a group devoted to scientific literature. In order that the exhibition should attain to that plane of excellence which would make it at once worthy of the man in whose honour it is being held, and an attraction to men of science, the organisation of the various groups and their sections has been entrusted to those who, by their work, are specially qualified in the various branches of science represented.

The groups of microbiology and collective hygiene are naturally the largest and perhaps the most interesting. The former, under the presidency of Dr. Roux, comprises in all nine sections. There will be a section devoted to diseases of man, including bacteriological and immunological technique, and sections dealing with vaccinia and vaccine institutes, tropical diseases and hygiene, diseases of plants, veterinary diseases, diseases of silkworms and other insects, parasitic insects, nitrification and sterilisation of soil —a most comprehensive list. The group of collective hygiene, with its six sections, is to deal with matters of the greatest importance, such as industrial diseases, tuberculosis, venereal diseases, cancer, maternity and infant welfare, military hygiene, and the organisation and installation of hospitals; and the names of such well-known scientific men as Dr. Calmette and Dr. Louis Martin, among the presidents of these sections, is a guarantee of the standard of excellence which will be reached in this group. But it is not only the man of science who will find interest in this exhibition. The sciences of chemistry and microbiology find their application throughout industry and in all phases of our modern civilisation. It is one of the objects of this exhibition to emphasise this interdependence of science and industry, and, to judge from the list of industries which will be represented by exhibits in the various groups, this aspect of the question has not been overlooked.

The exhibition will remain open till October, and during this period congresses on various subjects are to be held. In this manner it is proposed to discuss such subjects as tuberculosis, housing, town hygiene, cancer, leprosy, syphilis, puerperal fever, and milk. The general secretary of the exhibition is Prof. Borrel, director of the Institute of Hygiene and Bacteriology of Strasbourg.

Chemical Characteristics of Australian Trees.

MR. HENRY G. SMITH, of Sydney, in his presidential address to the section of Chemistry at the meeting of the Australasian Association for the Advancement of Science, held at Wellington in January last, dealt particularly with the elucidation of some chemical characteristics of Australian vegetation, treating the subject in relation to the generalisations that may reasonably be advanced from the consideration of the results secured by the phyto-chemical study of the principal Australian genera, such as Eucalyptus and Callitris. This study extended over a period of more than thirty years, and was undertaken in conjunction with his botanical colleague, Mr. R. T. Baker.

Some of the chemical peculiarities brought to light during this investigation appear to be characteristic of this unique flora, and indicate a distinct uniformity in progressive characters, suggesting evolutionary processes as the directing influence in the production of the numerous groups and species which, in the aggregate, go to form the more important genera.

The genus Eucalyptus apparently originated in what is at present the western and north-western portions of Australia, and as it spread eastward and experienced varying degrees of soil and climate the conditions demanded by these new locations and climatic changes were met by the responding characteristics of the genus.

The chemical peculiarities of nearly two hundred distinct species were determined, so that many data were obtained upon which to formulate the more recent theories regarding the formation of the distinctive groups.

Eucalyptus is essentially an oil-producing genus, and already about forty distinct chemical constituents have been isolated and characterised. These include 11 alcohols; 9 aldehydes; 2 phenols; 7 esters; 5 terpenes; 1 ketone; 1 sesquiterpene; 1 paraffin; and also cymene and cineol.

The two main factors controlling the chemical sequence throughout the genus may be stated in the following terms: (1) The same species of Eucalyptus has chemical properties of a comparatively constant nature wherever found growing under natural conditions, and (2) each constituent follows the sequence of species in increasing amount until a maximum is reached in one or more of them.

These conditions are not only true for the several oil products, but may also be applied to the astringent exudations or kinos produced in varying amounts by all the species. The characteristic features of these exudations are traceable right through the genus, and are particularly noticeable with the two crystalline substances, aromadendrin and eudesmin, found in the older species of the genus. These substances become extinct when the group of "ironbarks" is reached in the sequence of evolution, and are, of course, absent in all the more recent species, such as those belonging to the "stringybarks," "peppermints," "ashes," etc. Eudesmin is a particularly interesting substance, and occurs in the kinos of some species to the extent of ten per cent.

The address also dealt with the chemical peculiarities of the Australian Coniferæ, and in addition with the inorganic constituents peculiar to Eucalyptus trees, instancing the small amounts of mineral matter secreted in the timbers of those species which often occur as very large trees, such as *E. regnans*, *E. pilularis*, etc., a condition that suggests the reason for their continued growth and great size.

The occurrence of manganese, and its importance, were also discussed, the conclusions being based upon the results of much experimental work. It was shown fairly conclusively that the presence of manganese in such minute quantities cannot be considered as accidental, but a necessary constituent for successful growth of these trees, and that some species belonging to certain groups require a larger amount of manganese than is necessary for the growth of those belonging to other groups. The whole question evidently hinges around the action exerted by the enzymes in the structural formation of forest trees and their chemical constituents, and is thus a subject requiring long-continued chemical research and experiment before a reasonable solution of the problem can be expected.

Sunshine-Recording.

IN the sunny southern countries of Europe less general interest appears to be taken in the recording of sunshine duration than is the case in England, where a certain therapeutic importance is attached to an allotment of sunshine which in winter undoubtedly falls below the optimum, although probably not to a greater extent than it rises above the optimum during a Mediterranean summer. However this may be, it is interesting to find the subject discussed in a short article by Guilio Grablovitz in the comparatively new Italian publication *La Meteorologia Pratica* for July and August 1922.

Various objections are raised to the continued use of the Italian words *insolazione* and *soleggiamento* to denote sunshine, the term *eliofania* being advocated instead, which would be anglicised to *heliophany*. It appears that the two former terms have medical significance in connexion with bad and good effects of exposure to the sun, from which our corresponding word "insolation," which is virtually equivalent to the more familiar "sunshine," is free.

Discussion in the paper turns upon the proper dates for replacing the equinoctial card by the summer and winter ones in the well-known Campbell-Stokes sunshine recorder, in which the sun's rays, focussed by a glass ball, leave a charred record. It is argued that the dates officially adopted for the change, namely, February 22, April 20, August 23, and October 22, when the declination of the sun is 12°, might with advantage be altered to March 1, April 11, September 3, and October 15, when the declination is 8°; because in the latter case, during the passage of the sun through a range of 47° between the solstices, the equinoctial, summer, and winter cards would each be used through an equal range, approximately of 16° ($16 \times 3 = 48$), whereas in the adopted practice the equinoctial card covers a range of 24° ($12 \times 4 = 48$). This is a purely technical point to be settled by reference to the design of the instrument; but on wider grounds, astronomical and climatic, the dates actually adopted seem more natural because, the solar declination being then 12° N. or S., that is, practically half-way between 0° and 23½° N. or S., they mark what should be regarded as the real boundary between the solstitial and equinoctial periods of the year.

In connexion with sunshine-duration recorders, one can scarcely refrain from commenting upon the inadequate character of instruments which give no information about the quality or intensity of the recorded sunshine, and from expressing the hope that these will gradually be superseded by radiographs like the Callender recorder and Ångström pyrrheliometer, which indicate the amount of solar energy received in a given time. Such radiographs may not be all that is desired, but at least they show the difference between the intensity of insolation on different days, at different seasons, and in different latitudes or altitudes. They can, for example, differentiate in comparable measured terms between the fitful sunbeams of December and the fiery rays of June; or show, again, that a hot day in England with, say, an air temperature of 90° F. is thermally less fierce than a day in Italy having the same air temperature but under a force of insolation unknown in Northern Europe. The point is that equivalent air temperatures are not truly climatically equivalent unless associated with the same intensity of insolation, and it is well known what an important factor in the economy of living creatures is the direct radiation of light and heat.

L. C. W. B.

Trieste and Marine Biology.

DR. M. STENTA, director of the Natural History Museum in Trieste, delivered an address, in October 1921, at the Trieste meeting of the Italian Society for the Advancement of Science, on the important part played by Trieste in the study of marine biology, and the address has recently been published (*Atti Soc. Ital. Progr. Sci.*).

Dr. Stenta referred to the observations of Abbot Fortis published in 1771 on the islands of the Quarnero, and those of Abbot Olivi (1792), who gave, in his "Zoologia Adriatica," a catalogue of the animals of the Gulf of Venice. Almost all the naturalists who visited Trieste in the first half of last century were German; of these, two may be named—I. L. C. Gravenhorst, who recorded (1831) the results of his studies on various molluscs, echinoderms, and Anthozoa; and J. G. F. Will, who gave an account (1844) of the anatomy of Scyphozoa, ctenophores, and siphonophores. K. E. von Baer came in 1845 from Russia to Trieste to search for larvæ of echinoderms, but the results in that and in the following year were not very satisfactory. His visit, however, was fruitful in another respect, for he encouraged Koch, a young Swiss merchant resident in Trieste and an ardent collector, in his project of founding a museum of the Adriatic fauna, which became the centre of studies on the Gulf of Venice. Johannes Müller spent the autumn of 1850 in Trieste working on the development of echinoderms and worms, and in the neighbouring bay of Muggia he discovered in *Synapta digitata* the parasitic mollusc *Entoconcha mirabilis*.

Among many who worked at the museum between 1850 and 1870 were Oscar Schmidt, who carried on researches on sponges; A. E. Grube, who examined the annelids and discovered the parasitic rotifer *Seison nebaliae*; and Kowalevsky, who described (1868) the remarkable sexual dimorphism in *Bonellia viridis*. In 1874 the Adriatic Society of Natural Science was founded, and the 27 volumes of its Bulletin are rich in observations on the biology of the area.

In 1875 the Institute of Marine Biology was established by the Austrian Government, and many famous naturalists have worked in its laboratories, *e.g.* Metschnikoff, on intracellular digestion and phagocytosis; Kowalevsky, on medusæ; Driesch, on the development of isolated blastomeres; the brothers Hertwig, F. E. Schultze, K. Grobben, and Hatschek.

In 1900 the zoological station was enlarged and reorganised under the new director, Prof. C. I. Cori. A list of the more important investigations carried on at the laboratory from that time until 1915 is given by Dr. Stenta, but it is too long to quote here. Mention may, however, be made of Friedländer's investigation of the constitution of the purple secretion of Murex, for which 14,000 specimens were collected; Heider's work on the development of Balanoglossus; and Przibram's researches on regeneration in Crustacea. There were also several investigations in applied zoology: the culture of sponges, the coral fishery, and parasitic protozoa of fishes.

We gather from the concluding part of the address that the Italian Royal Committee for Marine Investigation, which took over the zoological stations at Trieste and Rovigno, proposes to suppress the former, and Dr. Stenta puts forward a plea for its retention.

Animal Nutrition.[1]

TWO series of Research Bulletins which have recently reached this country from America provide remarkable examples of the laborious—one may almost say meticulous—methods which distinguish much of the work now being conducted at the Agricultural Experiment Stations in the United States. The bulletins in question come from the stations attached to the Universities of Missouri and Minnesota respectively. In both cases the aim was to find out by actual chemical analysis the constitution of the bodies of cattle at various ages. In the case of the Minnesota investigations, sixty-three bullocks, at all ages from three months to two years and over, were slaughtered and analyses made of the bodies, not merely as a whole, but under such divisions as flesh, offal, skin, blood, etc. In the case of the Missouri investigations, thirty animals were slaughtered and analysed in much greater detail. Separate figures for all descriptions of edible joints and for each organ of the body are given. It does not require much acquaintance with chemical routine to realise the extraordinary labour involved in reducing the separate parts of the body of an animal to a fine pulp from which uniform samples of every description of tissue can be drawn. So far as this country is concerned, the attempt has been made only once—by Lawes and Gilbert many years ago—and then with difficulty three animals in all were completely analysed.

The object of these investigations may be stated very simply. The animal food consumed by man represents vegetable food converted by stock into "meat." It is desirable to know the extent of the waste involved in this process of conversion. Incidentally, we also wish to know the relation between the amount of this waste and the age of the animal, progressively. The older and larger the animal, the greater the waste, and consequently the more costly the product. Above all, it is desirable to ascertain the relation between protein consumed and protein stored, for the most costly food of all is vegetable protein, supplied in the form of costly oil-cakes; furthermore, as the raw material is generally imported from abroad, the economic loss in Great Britain is very great. There can be no doubt that, as matters stand, millions of money are being wasted by farmers in bringing beasts to a state of fatness required neither by the taste of the modern consumer nor by the human body's need for fat. The supplies of cheap vegetable carbohydrates, from which animal fat can be manufactured, are now greater than they were in our grandfathers' time, but the farmer still goes on producing from imported feeding-stuffs rich in protein, animal fat in wasteful quantity. More than 30 per cent. of the body weight of a "fat beast" is merely fat. Thanks to the labours of these American workers, this point can now be driven home. We can trace at every stage of an animal's growth what happens to the food it consumes, and how as it grows older its conversion factor grows smaller, until, ultimately, it stores only one-twentieth of what it consumes: how again it turns a larger proportion of costly protein into fat, rejecting more and more of nitrogenous matter.

In these days when, we are told, British agriculture is faced with ruin, it is unfortunate that agriculturists apparently cannot be persuaded to give up one of the most costly and wasteful processes of their industry. It is not the farmer alone who is to blame. Both the butcher and the housewife conspire to maintain the demand for excessively fat meat, and while the market demand is for fat stock, it is only to be expected that the present extravagant system of "fatting" beasts will continue.

[1] Studies in Animal Nutrition; University of Missouri, Research Bulletins, 53 *et seq.* Investigations in Beef Production, University of Minnesota, Bull. 193.

University and Educational Intelligence.

BIRMINGHAM.—Announcement is made of the Walter Myers studentship (value 300*l.* for one year) for research in any branch of medicine or pathology approved by the selection committee. The studentship is tenable at any approved university, laboratory, or other institution in the United Kingdom. Candidates may be of either sex, and must be graduates in medicine of the University of Birmingham of not more than five years' standing. The holder of the studentship will be required to devote his whole time to research. Further information may be obtained from the Dean of the Medical Faculty of the University.

CAMBRIDGE.—As announced in our issue of May 5, p. 621, a fund has been established by the family of the late Henry P. Davison, of New York, for the purpose of giving English University men a year's residence and study in the American Universities of Harvard, Yale, and Princeton. Three of these scholarships will be available for next year for Cambridge. The scholars will be selected from undergraduates or bachelors of arts now in residence, the election being on the basis of character, scholarship, and fitness to represent the University. There is to be no examination.

LEEDS.—In memory of the 326 members of the University who fell in the War, a piece of sculpture by Mr. Eric Gill, which will be fixed to the outer wall of the University Library, will be dedicated at the University on Friday, June 1. The University owes this impressive memorial to the generosity of the late Miss Frances Cross of Coney Garths, Ripon.

London.—Prof. E. D. Wiersma of the University of Groningen will deliver a free public lecture on "The Psychology of Epilepsy" at 5.15 o'clock on Thursday, May 24, in the Robert Barnes Hall, The Royal Society of Medicine, 1 Wimpole Street, W.1. The lecture will be in English.

Manchester.—The following resignations are announced: Dr. A. V. Hill, from the Brackenbury chair of physiology, on appointment to the Jodrell chair of physiology in the University of London; Mr. J. P. Headridge, from the lectureship in dental metallurgy; and Dr. J. Gray Clegg, from the lectureship in ophthalmology.

Arrangements are being made for broadcasting University public lectures by joining up the University with the Metropolitan Vickers Broadcasting Station.

It is stated by the Hong-Kong correspondent of the *Times* that Sir Catchick Paul Chater has presented a sum of 30,000*l*. as a contribution towards the general purposes of the University of Hong-Kong.

The Ramsay Memorial Trustees will, at the end of June, consider applications for two Ramsay Memorial fellowships for chemical research. The value of the fellowships will be 250*l*. per annum, to which may be added a grant for expenses not exceeding 50*l*. per annum, and one will be limited to candidates educated in Glasgow. Full particulars as to the conditions of the award are obtainable from Dr. Walter W. Seton, Secretary, Ramsay Memorial Fellowships Trust, University College, London, W.C.1.

The Board of Education has just published a list of fifty-two holiday courses, which will be held at different times during the present year but mostly in the summer months. Nineteen of these courses are organised by Universities and University Colleges (of which nine are held in connexion with the tutorial classes of the Workers' Educational Association), seven by Local Education Authorities, and the remaining twenty-six by various educational bodies. In addition to general courses for teachers there are special courses, among which are the following: economics, gardening, geography, geology, handwork, international relations, languages, librarianship, medieval and modern universities, mine-surveying, physical training, psychology, social service, speech training, and the Victorian Age. The dates of each course, the fees, principal subjects of instruction, address of Local Secretary, and other details are given with each entry. This list can be obtained direct from H.M. Stationery Office, Imperial House, Kingsway, London, W.C.2, or through any bookseller, price 6*d*.

Examination and inspection of secondary schools in the United States are undertaken by several independent and, in many cases, overlapping agencies, namely—State officers of education, universities or colleges, and accrediting associations such as the Association of Colleges and Secondary Schools of the Southern States, the New England College Entrance Certificate Board, and the North Central Association of Colleges and Secondary Schools. In 1913 the United States Bureau of Education prepared a directory of schools (more than 13,000) which had satisfied or been "accredited" by these various agencies as equipped for preparing students for colleges requiring 15 "units" for unconditioned admission, and a fourth edition of the directory has recently been published as Bulletin, 1922, No. 11. The definitions of standards involved in the processes of "accrediting," as set out in the Bulletin, are instructive. One on which the various agencies are all agreed is the above-mentioned "unit" of measurement of secondary school work: a year's study in any subject, constituting approximately a quarter of a full year's work, on the assumption that the school year is from 36 to 40 weeks and that the study is pursued for 4 or 5 periods (of from 40 to 60 minutes each) per week, it being understood that a satisfactory year's work in any subject cannot usually be accomplished in less than 120 sixty-minute hours or their equivalent. The subjects recognised by the various accrediting bodies vary greatly: the College Entrance Examination Board, for example, permits the inclusion of English, mathematics, languages, history, science, and drawing only, whereas the University of California accepts also mechanic arts, agriculture, home economics, music, book-keeping, and stenography and typewriting. Almost all the State universities specify among their admission requirements three units of English and two and a half of mathematics; nearly half of them require at least one unit of science; more than half require history and foreign languages; only three require a classical language.

"The Rising Cost of Education" in America is one of the main subjects dealt with in the recently published 17th annual report of the president of the Carnegie Foundation for the Advancement of Teaching. During the past thirty years, while the national income increased by 500 per cent., the expenditure for public schools—elementary and secondary—rose by 700 per cent., and for universities, colleges, and technological schools by 1400 per cent. During the last decade the pace of growth increased, and an increasing share of the cost was transferred to the Federal treasury. The people still believe in education, but are becoming somewhat critical as to whether the system for which they are paying is altogether justifying itself in its results; and, in any case, the fact has to be faced that the cost of schools cannot be indefinitely increased: "Education must reckon with economic necessity." So far the president's review discloses a situation identical with that brought to light in Great Britain by the Geddes report. Analysis of the factors shows that in America, as in England, the increase in salaries since the War has been very great, but that in America it has been specially pronounced in the colleges: in the institutions associated with the Foundation, professors' salaries rose in four years by 28-83 per cent. The main purpose of the report, however, is to emphasise the fact that the rise in cost has been largely due to a change in the conception of education itself and the part the school is to play in the social order: to the widespread notion that formal education is not only the one way to advancement but also "the panacea for all social and political disorders"; to the admission to high schools and colleges of great numbers of pupils ill fitted for them; to the so-called "enrichment" of the curriculum with a great variety of subjects in which a mere smattering of knowledge is imparted; to the introduction of vocational training into the high schools; and to "acceptance of the notion of scientific research as the primary object of the college teacher." "Both financial necessity and educational sincerity require a return to a feasible and educationally sound conception of the school."

Societies and Academies.

LONDON.

Royal Society, May 3.—**Leonard Hill** and **A. Eidinow**: The influence of temperature on the biological action of light. The biological action of light is accelerated by warmth and retarded by cold. This is true for bacteria, infusoria and human skin. The temperature coefficient for infusoria, between 1° and 20° C., is about 3·0. By adequate exposure to cool air over-action of the sun on the skin can be prevented. The proven success of heliotherapy applied to children with surgical tuberculosis can probably be secured for cases of phthisis if these are no longer exposed in hot sun-boxes, but suitably stripped and exposed in cool air.—**F. A. E. Crew**: Studies in intersexuality. I.—A peculiar type of developmental intersexuality in the male of the domesticated mammals. Individuals, regarded as females during the earlier part of their lives, later assume the behaviour and the secondary sexual characters of males. They form a series according to the degree of imperfection of the external genitalia and the relative degree of development of the derivatives of the Wolffian and Müllerian ducts. In all there were paired but mal-descended testes. The condition appears to be the result of the absence during the period of differentiation of the sex organisation of that minimum stimulus provided by the sex-differentiating substance, of the sex-hormone, in a zygotic male. The Wolffian and Müllerian ducts pursue an equal and parallel development. The degree of intersexuality varies with the stage during the period of sex-differentiation at which the necessary minimum stimulus was exhibited. Since the assumption of the secondary sexual characters of the male type is normal in time, either the minimum stimulus is ultimately exhibited, or else there is a different threshold of response to the action of the sex-differentiating stimulus on the part of various structures belonging to the sex-equipment.—**E. J. Morgan** and **J. H. Quastel**: The reduction of methylene blue by iron compounds. The restoration of the power to reduce methylene blue to boiled milk by means of ferrous sulphate solution is due to the inorganic constituents of the milk. Methylene blue is reduced by ferrous sulphate solution in the presence of sodium hydroxide, carbonate, bicarbonate or phosphate, and of the sodium salts of acids such as acetic, tartaric, or citric. Ferrous sulphate solution alone will not effect any perceptible reduction. Two ferrous molecules always react with one of methylene blue. The mechanism of the reduction appears to depend on the relative affinities of the oxygen acceptor for the hydroxyl ion and of the hydrogen acceptor for the hydrogen ion.—**C. F. Cooper**: The skull and dentition of *Paraceratherium bugtiense*. A genus of aberrant rhinoceroses from the Lower Miocene deposits of Dera Bugti. A complete lower jaw, a nearly complete skull, parts of three other skulls, several fragments of lower jaws, numerous loose teeth, and parts of the milk dentition found in Baluchistan are discussed. The lower pair of incisors have the form of tusks turned downward. Even in the oldest specimens they show practically no signs of having been used. The condition of the premolar dentition shows the animal to be in an early state of evolution, but on a side line, with some possible connexion with the early North American Aceratheres. Similar teeth were found in Turkestan by Borrissyak and described by him as belonging to Indricotherium (=Baluchitherium), and a skull has been discovered in Mongolia by the American Museum expedition and attributed to Baluchitherium. It has the enormous length of 5 ft., as against a skull length of 3 ft. in the present form, which makes it the more probable that the two genera are properly separated.—**W. L. Balls**: The determiners of cellulose structure as seen in the cell walls of cotton hairs. The use of plane and circularly polarised light and of immature hairs shows that the reversals of the spiral fibrillar structure appear in full number, as soon as the secondary wall is visible, indicating predetermination thereof during growth in length. On development of the pre-cellulose, the primary wall shows a pair of opposed spirals with pitches corresponding to that of the slip spirals of the secondary wall. These slip spirals are structurally connected with the quicker pit spirals and invariably opposed to the latter in direction; the tangents of their angles are in the ratio of 4 : 1, which suggests polymerisation from the pre-cellulose of the primary wall. The rotation of the plane of polarisation by a single layer of secondary cell-wall is inverted on opposite sides of a reversal point; thus the molecular structures of the right-hand and left-hand areas would seem to be mirror-images. The probable space-lattice conformation of cotton and other celluloses seems to indicate a modernised restatement of Nägeli's micellar theory.—**I. de B. Daly**: The influence of mechanical conditions of the circulation on the electro-cardiogram. Exercise in man produces changes in the electro-cardiogram which are similar to those obtained in anæsthetised animals by simultaneous stimulation of both stellate ganglia. Partial or complete denervation of the heart was produced in a dog. Alterations in the mechanical conditions of the circulation were brought about (i.) by partial compression of the systemic aorta at various levels in the body, and (ii.) by changing the conditions of the artificial circulation of the heart-lung preparation. The most marked changes in the electro-cardiogram occurred when the arch of the aorta was partially clamped. The form of the electro-cardiogram of the denervated mammalian heart probably remains unaltered when the increase in work of the heart is produced in a physiological manner.

Zoological Society, April 10.—Dr. A. Smith Woodward, vice-president, in the chair.—**G. C. Robson**: The snail *Planorbis sufourii* Graells, the intermediate host of *Schistosoma* (*Bilharzia*) *hæmatobium*, in Portugal.—**C. F. Sonntag**: On the anatomy, physiology and pathology of the chimpanzee.—**K. Kostanecki**: On a remnant of the omphalo-mesenteric arteries in the manatee.

Royal Microscopical Society, April 18.—Prof. F. J. Cheshire, president, in the chair.—**D. W. Cutler**: The Protozoa of the soil. Data were obtained from 365 consecutive daily counts of the numbers of bacteria and protozoa in a normal field soil. Fourteen-day averages of the total numbers showed marked seasonal changes; the organisms being most numerous in November and fewest during February. An inverse relationship exists between the numbers of bacteria and the active amœbæ. A two-day periodicity obtains for the active numbers of one species of flagellate. Azotobacter, in the presence of Protozoa, can fix more atmospheric nitrogen than when alone. Experiments on the reproductive rate of *Colpidium colpoda* show that, according to the age of the parent culture, death of some of the organisms follows inoculation into fresh medium; also that death occurs even during the period of maximum reproduction.—**A. C. Seward**: The use of the microscope in palæobotanical research. Microscopical investigation can be applied to plants which have been preserved in different states, are of different geological age, and belong to various divisions of the vegetable kingdom, and reference was made to the examination of fragments detached from imperfectly petrified stems which cannot be cut into sections. Petrified roots of a Cretaceous fern were described in illustration of the difficulty of distinguishing between inorganic and organic structures. The architectural basis of plant organs has been remarkably persistent through the ages. Recent palæobotanical discoveries have thrown little light on the problem of evolution.

Manchester.

Literary and Philosophical Society, April 24.—Mr. W. H. Todd, vice-president, in the chair.—T. H. **Pear**: A new type of number form. The numbers appear to be on small square blocks. It is possible, by imaging a series of them tilted backwards, to see at a glance a numerical series like 1, 2, 4, 8, etc., or even 1, $\frac{1}{2}$, $\frac{1}{4}$, . . . $\frac{1}{128}$. To see this last fraction it is necessary, in imagination, to approach the form very closely. Complex numbers like $\sqrt{-1}$ and $\sqrt{-9}$ can be seen vaguely in undefined areas in the neighbourhood of 1 and 9 respectively. The form even represents a billion and a trillion, though it is difficult to see beyond a source of light (to look into which is like looking at the sun) which exists near the place representing a million.—W. J. **Perry**: The neurological basis of human behaviour in society. A calm, happy, peaceful behaviour is normal for man as he is at present constituted. Since this type of behaviour is universal among peoples in the "food-gathering" stage of culture, it must have been acquired at an early stage in the evolution of man, who, in the course of the development of civilisation, has, speaking generally, exhibited war-like, cruel, and angry types of behaviour to an increasing degree. An explanation is sought by considering man's brain as consisting of two distinct parts—the optic thalamus and the cerebral cortex, or neo-pallium. The optic thalamus represents the dominant part of the brain of the lower vertebrates. The cortex is concerned with "epicritic" sensibility, the thalamus with emotional tone. The increasingly violent behaviour of man as civilisation has proceeded can be referred to stimuli, due to certain social institutions, which, by unduly exciting the thalamus, undermine the control established by the cortex. The removal of those institutions should therefore have tremendous effects on human behaviour.

Dublin.

Royal Dublin Society, April 24.—Prof. J. A. Scott in the chair.—A. E. **Clark**: Evidence of displacement of Carboniferous strata in County Sligo. Accurate plotting of the igneous dykes on the N. coast of Co. Sligo shows that a strip of country four miles wide, lying just W. of Aughris Head, has been displaced southwards between parallel faults for a distance varying from a quarter of a mile on the W. side to three-quarters of a mile on the E.—E. J. **Sheehy**: The comparative values of protein, fat, and carbohydrate for the production of milk fat. By feeding lactating goats for successive periods with carbohydrate, fat, and protein the relative values of these materials have been ascertained. Protein (in excess of that required for milk protein and for body maintenance) and carbohydrate are equal in value, and fat is $2\frac{1}{4}$ times as valuable as either. In rations containing less than a certain quantity of fat, however, the substitution of extra fat for some of the carbohydrate gives results which credit fat with a value much higher than $2\frac{1}{4}$ times that of carbohydrate. In addition to its food value, fat in the ration stimulates milk fat secretion, but a small quantity suffices for the latter purpose.—T. J. **Nolan** and H. W. **Clapham**: The utilisation of monomethylaniline in the production of tetryl. In the nitration of monomethylaniline, metanitrotetryl is formed in addition to tetryl; also crude tetryl formed from commercial dimethylaniline frequently contains the same impurity. The use of monomethylaniline for the manufacture of tetryl has, apart from its cost, been hitherto regarded with disfavour. Tetryl containing not more than almost inappreciable quantities of metanitrotetryl can be obtained in good yield from monomethylaniline if the latter, before nitration, is converted into its nitroso derivative. The nitroso group influences the course of the nitration.

Paris.

Academy of Sciences, April 9.—M. Albin Haller in the chair.—A. **Guntz** and **Benoit**: The ionising power of fused lithium hydride.—Maurice **Lecat**: The generalisation and modifications of a theorem of Frobenius.—E. O. **Lovett**: Certain functional properties of conics and their generalisations.—Maurice **Fréchet**: The existence of ($\mathfrak{D}$) classes not complete.—M. **Mandelbrojt**: Taylor's series with gaps.—H. C. **Levinson**: The gravitational field of n bodies in the theory of relativity.—Ernest **Csilser**: Some dynamical and geometrical properties of movement resulting from the conditions of M. Angelesco.—G. **Laville**: The propagation of maintained waves along an iron wire. The experimental results are in good agreement with the formula developed from Maxwell's equations, but the formula deduced from Kirchoff's theory leads to results not in accord with experiment.—G. **Vavon** and A. **Husson**: Catalysis and steric hindrance. A study of the reduction of cinnamic acid and esters and alkylcinnamic acids and esters by hydrogen in the presence of a platinum catalyst. The experimental results are in agreement with the predictions of the theory of steric hindrance. J. F. **Durand**: The action of acetylene on zinc ethyl. Acetylene was passed into a solution of zinc ethyl in petroleum ether, and the yellow solid produced rapidly separated. It gave the reactions of a zinc acetylide; water gave acetylene and zinc hydroxide. Mercury diphenyl treated in a similar manner gave no reaction.—W. J. **Vernadsky**: Mendelejeffite, a new radioactive mineral. This mineral, found near Sludjanka (on lake Baïkal), is a calcium urano-titano-niobate, containing about 23·5 per cent. of U_3O_8. Its crystalline form is described.—Ph. **Schereschewsky** and Ph. **Wehrlé**: Elements of a synthesis of the French and Norwegian methods of weather forecasts. —Ch. **Janet**: The ontogenesis of *Volvox aureus*.—Lucien **Daniel**: Variations of perfumes under the influence of grafting. Experiments on grafting with wormwood (*Artemisis Absinthium*) have shown that the modifications in the leaves and seeds are accompanied by changes in the character of the essential oil: the taste and perfume may improve or deteriorate with differences in the species grafted.—Raphael **Dubois**: Tears and the functions of the lachrymal gland. An enzyme has been isolated from the lachrymal glands of the cow: it is neither an oxydase nor a peroxydase, but is a diastase hydrolysing starch like ptyaline; the name lacrymase is given to it.—M. **Lopez-Lomba** and Mme. **Randoin**: The production of scurvy in the guinea-pig and young rabbit by means of a new food regime, complete and in biochemical equilibrium, deprived only of the factor C. A food is described containing all the necessary constituents except factor C. The animals fed with this ration, plus 3 c.c. of lime juice (factor C), made normal growth. All the other animals fed with the same ration, minus factor C, after a short period of rapid growth, developed scurvy and died.—E. Lesné, Christou, and Vaglianos: The passage into the milk of the C vitamins introduced by other means than the mouth.—E. Fernandez Galiano: The rhythmic contractions of Vorticella.—A. L. Herrera: The imitation of plasmodia and chromatic structures by sodium silicate coloured with ivory black and drops of alcohol in diffusion. If drops of absolute alcohol are allowed to diffuse into a syrupy solution of sodium silicate coloured with ivory black, remarkable imitations of cells, nuclei, and chromatic structures are produced. The structure can be preserved fairly well by washing the card with weak alcohol to remove traces of alkali.—A. Policard: The mineralisation of histological sections by calcination, and its interest as a general histochemical method. The method, described in detail, permits the localisation of the mineral elements in the positions they occupy in the living tissue.—René Jeannel: The evolution of the copulatory apparatus in the genus Choleva. The sexual characters in this genus, both in the male and female, are more trustworthy than the external characters in defining the species.—Lucien Semichon: The preparation of wine by continuous fermentation: selection of the ferments by the alcohol already formed. Natural fermentation is due to elliptical yeasts, wild and apiculated yeasts, Dematium, spores of cryptogams, and various bacteria, all of which are objectionable except the first. Sterilisation of the must, followed by the introduction of a pure yeast culture, is economically impracticable. In a must containing 5 per cent. of alcohol the growth of the elliptic yeasts is favoured and the objectionable organisms do not develop freely. In practice, the addition of this amount of alcohol is not possible, but the same result can be obtained by a process of continuous fermentation. A portion of the must is started fermenting with a cultivated yeast, and after the necessary amount of alcohol has been produced, fresh must is added at a constant rate. The method has been successfully applied on the large scale.—Auguste Lumière and Henri Couturier: Barometric depression and anaphylactic shock. Guinea-pigs, sensitised by egg albumen, are partially protected against anaphylactic shock by placing under a bell jar in an atmosphere at about half the normal atmospheric pressure. The mortality in the animals thus treated was 40 per cent. against 80 per cent. when the animals were allowed to remain under normal pressure after the second injection.—Jules Amar: The law of vivireaction in pathology.

April 16.—M. Albin Haller in the chair.—Emile Picard: The singularities of harmonic functions.—Charles Richet: The spleen, a useful organ, but not essential. An account of experiments on the comparative effects of starvation of dogs with and without the spleen. Animals can survive for long periods after removal of the spleen: the experiments prove that animals without the spleen require more food to maintain their normal weight, and die more quickly than normal animals when deprived of food.—M. d'Ocagne: Normals of quadrics along their lines of curvature. Charles Nicolle, Et. Burnet, and E. Conseil: The micro-organism of epizootic abortion, distinguished from that of Mediterranean fever by the absence of pathogenic power for man. *Micrococcus melitensis* (the organism of Maltese fever) and *Bacillus abortus* present striking similarities in their morphological characters, cultures, and pathogenic power towards the animals commonly used in laboratory experiments; but *B. abortus* proves to be innocuous to man. Cultures injected into five voluntary subjects caused neither fever nor any other trouble: hæmocultures remained sterile and the agglutinating power was generally not developed.—Georges Bouligand: The singularities of harmonic functions.—Gaston Bertrand: The problem of Dirichlet and the potential of the simple layer.—G. C. Evans and H. E. Bray: Poisson's integral generalised.—André Planiol: The influence of velocity and of temperature on the friction losses in explosion motors. The engine was driven by an electric motor and the power used measured electrically: in one set of experiments the air port was fully open, in another the air admitted was reduced to a minimum. The frictional losses were found to be a linear function of the turns per minute, the rate of increase being much larger than was expected. Experiments were also made on the effect of varying the temperature of the cooling water.—Wladimir de Belaevsky: A problem of elasticity in two dimensions.—M. Mesnager: Observations on the preceding communication.—Antonio Cabreira: A method of obtaining the geographical co-ordinates at any height of a star.—Charles Nordmann and C. Le Morvan: Observations of the Pleiades with the heterochrome photometer of the Paris Observatory. A new method for determining stellar parallax by photometry. The photometric measurements given show that, for the stars of the Pleiades studied, there exists a clear relation between the intensity distribution in the visible spectrum and the absolute magnitude of the star.—P. Noaillon: Superficial circulation.—M. Hadamard: Remarks on the preceding communication.—Albert Pérard: Study of some mercury and krypton radiations with the view of their applications in metrology. The results of a large number of comparisons with the red cadmium line are given, with the view of detecting the presence of satellites of feeble intensity. None of the lines compared (neon, krypton, mercury) behaved as a simple symmetrical line.—Léon and Eugène Bloch: Spark spectra of higher order. Reply to a claim for priority by M. Dunoyer.—M. A. Catalan: Spectrum series and ionisation and resonance potentials of chromium and molybdenum.—L. J. Simon and A. J. A. Guillaumin: The determination of carbon and hydrogen by the use of a mixture of sulphuric acid and silver bichromate. The principle of the method is the determination of the carbon dioxide produced by heating a known amount of substance with a measured excess of the oxidising mixture, and the determination of the excess by the addition of an easily combustible substance (potassium methylsulphate), and a second measurement of carbon dioxide. Results of the application of the method to ten organic substances of varying types are given.—M. Lespieau: Some derivatives of the glycerol $(OH)CH_2 . CH(OH) . C \vdots C . CH_2(OH)$.—A. Wahl and W. Hansen: Isoindigotine and indine. Isoindigotine has been proved to be identical with Laurent's indine.—M. E. Denaeyer: The rocks collected by MM. Chudeau and Villatte in the central Sahara.—E. Schnaebelé: The tectonic origin of the valleys of the eastern slopes of the Vosges.—Louis Besson: Observation of a parhelion of 90°.—René Souèges: The embryogeny of the Valerianaceæ. The development of the embryo in *Valerianella olitoria*.—Pierre Georgévitch: The rôle of the centrosome in kinesis.—Mlle. Lucienne Blum: Modification of plants submitted to culture under glass. Comparative studies of the same plants grown under glass and in the open air. Under glass the plant appears to be stabilised at an earlier stage of its growth. The organs of secretion are always more abundant in the plant under glass.—Henry **Cardot** and Henri **Laugier**: The adaptation, transmission of acquired characters, selection by vital concurrence in the lactic ferment.—Edouard **Chatton** and Mme. M. **Chatton**: Sexuality provoked experimentally in an Infusoria, *Glaucoma scintillans*. Predominance of the conditions of the medium in its determinism.—Jules **Barrois**: The development of Echinoderms.

CALCUTTA.

Asiatic Society of Bengal, April 4.—M. A. **Wali**: Hinduism according to Muslim Ṣufis. Some Sufi scholars of India conclude that India, like other countries, has produced prophets and saints, and that the teachings of the Vedas and Upanishads are in accordance with the Muslim Scriptures.—W. **Ivanow**: A "witch-case" in medieval India. A curious and complete case of sorcery in the form technically called envoûtement from the Siyaru 'l-Ārifīn (± A.D. 1530) which is translated and annotated.—H. **Mitra**: Epigraphic notes.—H. C. **Robinson** and C. B. **Kloss**: Some remarks on Mr. C. Stuart Baker's new volume on the Birds (second edition) in the "Fauna of British India." A number of corrections are proposed for the Malaisian and eastern Indo-Chinese species dealt with.—Zoological results of the Percy Sladen Trust Expedition to Yuñnan in 1922, under the leadership of Prof. J. W. Gregory:—J. C. **Brown**: An account of the country traversed by the Expedition.—N. **Annandale**: Land molluscs. Eighteen species and one local race are represented, of which five species (all belonging to the genus Buluminus or Ena) and one race of *Helicarion resinaceus* Heude are described as new.—B. **Prasad**: Bivalve molluscs. Six species of Corbicula from W. Yunnan, a Unionid and a Sphærium are recorded from Lake Tali.—S. W. **Kemp**: Decapod Crustacea. Three crabs and a prawn of the genus Caridina were collected. One of the crabs is a new species of Potamiscus, while another (*Potamon atkinsonianum*) is interesting as being a Himalayan form. The Caridina from Lake Tali is new and is remarkable on account of the secondary sexual characters of the male.

Official Publications Received.

Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1921. Faites et rédigées par Bror Hedemo. Pp. v+66. (Stockholm: Victor Pettersons Bokindustriaktiebolag.)

Report of the Kodaikanal Observatory for the Year 1922. Pp. 8. (Madras: Government Press.) 6 annas.

Fourth Annual Report of the Governors of the Imperial Mineral Resources Bureau. Pp. 24. (London.)

Medical Research Council. Third Annual Report of the Industrial Fatigue Research Board to 31st December 1922 (including Personal Contributions from Investigators). Pp. 83. (London: H.M. Stationery Office.) 2s. net.

Rocznik Astronomiczny Obserwatorjum Krakowskiego na rok 1923. Tom. 2. Pp. iv+167. (Kraków.) 2s. 6d.

Diary of Societies.

SATURDAY, MAY 12.

ANNUAL CONFERENCE OF THE UNIVERSITIES OF GREAT BRITAIN AND IRELAND (at King's College), at 11.—Sir Theodore Morison and others: Discussion on The Financial Outlook of the Universities.—Sir W. Henry Hadow and others: Discussion on Music as a University Subject.—Sir William H. Beveridge and others: Discussion on the Universities and Training for Administrative and Municipal Life.—A. Greenwood, the Master of Balliol, and others: Discussion on Labour and the Universities.

MONDAY, MAY 14.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof. T. G. Pinches: Assyro-Babylonian Israel Likenesses and Contrasts.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Prof. J. W. Gregory: The Banda Arc; its Structure and Geographical Relations.

FARADAY SOCIETY (at Chemical Society), at 7.50 (Annual General Meeting); at 8.—E. P. Perman and H. L. Saunders: The Vapour Pressures of Concentrated Cane Sugar Solutions.—E. W. J. Mardles: The Elasticity of Organogels of Cellulose Acetate.—D. Stockdale: An Example of Polymorphism in an Intermetallic Compound.—A. L. Norbury: Some Experiments on the Hardness of Spontaneous Annealing of Lead.—F. C. Thompson and E. Whitehead: Some Notes on the Etching Properties of Alpha and Gamma Forms of Tricarbide of Iron.

ROYAL SOCIETY OF ARTS, at 8.—S. S. Cook: The Development of the Steam Turbine (3). (Howard Lectures.)

TUESDAY, MAY 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. C. Seward: Arctic Vegetation of Past Ages. (Tyndall Lecture.)

ROYAL STATISTICAL SOCIETY, at 5.15.—D. R. Wilson: On Some Recent Contributions to the Study of Industrial Fatigue.

INSTITUTE OF TRANSPORT (at Institution of Electrical Engineers), at 5.30.—G. J. Shave: The Design and Maintenance of Commercial Motor Vehicles.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—J. H. P. Murray: Native Administration in Papua.

SOCIOLOGICAL SOCIETY (at Leplay House, 65 Belgrave Road), at 8.15.—Dr. G. Slater: The Psychological Basis of Economic Theory.

WEDNESDAY, MAY 16.

ROYAL METEOROLOGICAL SOCIETY, at 5.—M. de Carle S. Salter and J. Glasspoole: The Fluctuations of Annual Rainfall in the British Isles considered cartographically.—A. W. Clayden: (*a*) An Improved Actinograph. (*b*) Note on the Influence of a Glass Shade.—Capt. E. E. Benest: Notes on the "Sumatras" of the Malacca Straits.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—W. B. R. King: The Upper Ordovician Rocks of the South-Western Berwyn Hills.—Prof. W. J. Pugh: The Geology of the District around Corris and Aberllefenni (Merionethshire).

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications of the Microscope Section), at 7.—L. Taverner: The Principles and Application of Technical Metallurgical Microscopy.—W. M. Ames: Applications of the Microscope in the Manufacture of Rubber.

ROYAL SOCIETY OF ARTS, at 8.—L. Gaster: Industrial Lighting and the Prevention of Accidents.

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Strand), at 8.—Earl Russell: Progress and the Law (to be followed by a discussion).

THURSDAY, MAY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. G. Coker: Engineering Problems solved by Photo-elastic Methods (1). Improvement in Apparatus: Contact Pressures and Stresses.

ROYAL SOCIETY, at 4.30.—Dr. A. E. H. Tutton: (1) A Universal Interferometer. (2) A Wave-length Torsometer and its Use with the Universal Interferometer.—Prof. L. N. G. Filon and F. C. Harris: The Diphasic Nature of Glass as shown by Photo-elastic Observations.—Prof. C. E. Inglis: Stress Distribution in a Rectangular Plate having two Opposing Edges sheared in Opposite Directions.—Prof T. H. Havelock: Studies in Wave Resistance—Influence of the Form of the Water-plane Section of the Ship.—W. M. H. Greaves: A certain Family of Periodic Solutions of Differential Equations, with an Application to the Triode Oscillator.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

RONTGEN SOCIETY AND THE ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (First Annual Joint Meeting) (in the Barnes Hall, Royal Society of Medicine), at 5.30.—Dr. A. W. George: The Pathological Gall Bladder. (Mackenzie Davidson Memorial Lecture.)

CHEMICAL SOCIETY, at 8 (and Informal Meeting).

FRIDAY, MAY 18.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Discussion.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—W. M. Mordey: Recent Studies in Alternating Magnetism.

SATURDAY, MAY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—J. B. McEwen: Harmonic Evolution.

PUBLIC LECTURES.

MONDAY, MAY 14.

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: Kant's Theory of Beauty and Sublimity. (Succeeding Lectures on May 22 and 28.)

TUESDAY, MAY 15.

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy. (Succeeding Lectures on May 16, 17, and 18.)

THURSDAY, MAY 17.

UNIVERSITY COLLEGE, at 2.30.—Prof. W. M. Flinders Petrie: Recent Discoveries of the British School of Archæology in Egypt. (Lecture repeated on May 23 at 5, and 26 at 3.)

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 4.30.—Prof. F. G. Hopkins: An Oxidising Agent in Living Tissues.

KING'S COLLEGE, at 5.30.—Principal L. P. Jacks: The Higher Education and the Community of Nations (Hibbert Lecture).

UNIVERSITY COLLEGE, at 5.30.—Prof. H. A. Lorentz: The Rotation of the Earth and its Influence on Optical Phenomena.—Dr. C. Pellizzi: Bernardino Telesio e la filosofia europea (in Italian.)

NATURE

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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School and Sex.[1]

IN 1920 the Consultative Committee of the Board of Education was reconstituted by Order in Council, and two urgent problems, of scientific character and far-reaching importance, were referred to it almost immediately for inquiry and advice: namely, first, what degree of differentiation is desirable, for boys and girls respectively, in the teaching of secondary schools; and, secondly, what use can be made, in the public system of education, of psychological tests. On the subject of the former reference the committee has received a vast body of evidence from a long list of witnesses—from medical men and psychologists, from teachers and examiners, from employers and business men; and the results of its inquiries have now been brought together in the pages of the report before us.

The first chapter, largely the work of the committee's secretary, Mr. R. F. Young, provides an admirable history of the curriculum in secondary schools for boys and girls; and this brief chronological survey is followed by a descriptive account of the present system of secondary education, so far as it bears upon the terms of the committee's reference. The education of what was once considered to be the weaker or the gentler sex has passed through two opposite phases, and is entering upon a third. The first was a phase of emphasised sex-difference based upon a supposed sex-inequality. It was the stage of feminine accomplishments and nothing more; it was also, therefore, a stage of educational inefficiency. During the second period—a period of reaction—education was based upon an assumed equality of the sexes; and reformers claimed, and endeavoured to secure, an identity of education for boys and girls, regardless of sex-difference. This, too, has not been entirely successful. The committee now discovers signs of a third stage—a stage which its own report will undoubtedly strengthen and reinforce—which recognises that equality does not demand identity, and would allow the widest possible freedom for all individuals, no matter which their sex might be, to develop their special talents, and to prepare themselves for their future duties, according to the peculiar tastes and capacities of each.

It is, however, the central section of the report which will command the greatest scientific interest. Here the committee has collected together all the available evidence dealing with the physical and mental differences between boys and girls during the critical years of development.

The known facts regarding the anatomical and

[1] Board of Education: Report of the Consultative Committee on Differentiation of the Curriculum for Boys and Girls respectively in Secondary Schools. Pp. xvi+193. (London: H.M. Stationery Office. 1923.) 2s. 9d. net.

physiological differences between the sexes are concisely summarised in a special appendix by Dr. J. G. Adami. The point of chief significance is the peculiarly rapid growth of the girls during the earlier phases of puberty. It is remarked that, as a consequence, the girl is almost adult while the boy is still adolescent. The memorandum ends by noticing that some of the most significant physiological differences are to be found in the activities of the glands of internal secretion; and, since recent research shows that these glands are intimately connected with emotional activity, this subtle physical difference is not without a deep psychological bearing.

As regards psychological differences generally, the committee has found that two opposing views appear to be entertained by various persons who have expressed opinions upon the subject. The first view maintains that "the higher the level reached in the development both of species and of individuals, the greater is the sex divergence"; and concludes that "educationally the first and safest classification is that which is based upon sex." The second view insists that "sex is the cause of only a small fraction of the mental differences between individuals," the divergences of man from man, and of woman from woman, being far greater than those between one sex and the other.

The committee has reviewed the few scientific investigations carried out upon this problem both in England and in America, and has manifestly decided that the weight of the evidence is upon the side of the second of these alternative beliefs. It has been stated, upon statistical grounds, that the largest sex-differences are physical differences—differences in height, in weight, and in bodily strength. Intellectual differences are far smaller; and here again the wider divergences are discovered not upon the higher but upon the lower levels of the mind, namely, in processes involving simple sensory or motor activity, in sensation and in movement; in the higher and more complex processes—in general intelligence and in ability to reason—the differences during the school period are extremely small. In memory and retentiveness, it is true, girls seem to surpass boys, and women to surpass men; nor is this without an obvious educational bearing. But of all psychological differences the most significant are those that relate to temperament and character. It is the quality of her emotions which, in the mental sphere, chiefly distinguishes the woman from the man.

Thus, inborn sex-differences in mentality are far slighter than has been popularly assumed. On the other hand, the cumulative result of the emotional divergence, and still more of the difference in social functions, has resulted in wide separation of interest and outlook, which is only in a small degree innate and ineradicable, and is chiefly due to tradition, and to the varying play of educational influences, whether conscious or unconscious.

In actual educational attainments, the differences vary considerably according to the circumstances of teaching. Where boys and girls have been taught together in mixed schools, the differences may be barely discernible; but where they have been taught in distinct departments, there the divergence is wider. Such differences can be measured easily by means of standardised scholastic tests.

The chief ascertainable differences appear to be the following: boys are better at arithmetic, mathematics, physical sciences, classical languages, geography, and drawing; girls are better at reading, spelling, handwriting, English composition, English literature, and possibly history, modern languages, and biological sciences. Here very plainly the effects of interest and tradition are at work quite as much as constitutional differences of intellectual capacity. The part played by the two factors, however, can only be disengaged by further inquiry.

Indeed, the most suggestive paragraphs of the whole report are those in which the committee emphasises the need for further research. It is pointed out that the provisional conclusions arrived at rest mainly upon the casual impressions and subjective opinions of schoolmasters—men of considerable practical experience, but of little or no psychological training; and it is urged that there is both room and need for a widespread co-operative inquiry, in which strict scientific methods shall be employed, and in which teachers, psychologists, and medical men shall all take part.

Science and Superstition of Primitive Mankind.

The Golden Bough: a Study in Magic and Religion. By Sir James George Frazer. Abridged Edition. Pp. xiv+756. (Macmillan and Co., Ltd., London, 1922.) 18*s*. net.

SIR JAMES FRAZER'S "Golden Bough" is in many respects the greatest achievement of anthropology—a science the short life-history of which allows still of a rapid survey and a correct apportionment of values. The book, like no other work, expresses the spirit of modern humanism—the union of classical scholarship with folk-lore and anthropology. The marble forms of antique legend and myth are made to lend their beauty to the crude and queer customs of the savage and the uncouth usages of the peasant, while the Gods and Heroes of Olympus receive in exchange the vitalising breath of life and reality from their humbler yet more animate counterparts.

It is difficult to review a new version of the work in the ordinary manner. It would be as presumptuous to assess the value of a universally acknowledged masterpiece of literary art and a classic of scholarship as it would be unnecessary to indicate the scope of a work known to every cultured man, a work which has exercised paramount influence over several branches of learning and has created new lines of scientific research. But though it is superfluous to praise the book or to explain it, the appearance of the abridged edition seems an opportune occasion for us anthropologists to undertake a little examination of conscience with regard to this classic. We all admit that we owe an immense debt to the author of the Golden Bough and to his work, but have we acquitted ourselves well of an obligation, have we given him his due in return? By this I mean, have we taken all that has been offered to us and made the most of it? Have we followed his lead to the end of the road, have we searched everywhere where the light of the Golden Bough has shone?

For this is the difference between the economic and the spiritual order of things: that in the former it is good to receive material benefits, and, speaking without cant, painful to give them; while in matters of the mind it is a joy to bestow but a burden to take, since this has to be done in an unselfish submission of the spirit, and requires obedience, discipline, and patience.

Surveying the immense influence exercised by this and Frazer's other works on contemporary humanistic literature, it might appear as if this quarry of inspiration and fact, however rich, must have by now become nearly exhausted. Literally half the subjects of modern anthropological argument and controversy have been submitted by Frazer for discussion: totemism, problems of the taboo, origins of kinship and chieftainship, primitive conceptions of the soul and spiritual life—the list could be drawn out indefinitely by going into more detail. In Great Britain, in France, in Germany and the United States, whole schools of anthropological science have flourished or grown rankly, respectively, on the ground broken and first cultivated by Frazer. It is enough to mention the names of Crawley, Marett, Durkheim, Hubert and Mauss, Van Gennep, Wundt, Freud and his school (in their anthropological studies), who in their work, some of it of the very first rank, are more or less dependent on Frazer and his initiative. Yet it would be easy to show that even this immense and most valuable Frazerian literature has left enormous areas within the enclosure of the Golden Bough ready for further cultivation.

It is not from the side of theory, however, that I wish to approach this great work, but, as a field-worker, from the point of view of actual research among savage races. The test of a scientific achievement lies in its power of anticipation and of prophecy: a sound theory must be the forerunner of empirical discoveries, it must allow us to foreshadow new facts not yet ascertained by observation. It is not when a man talks to us about things we have seen already, but when, from his study, he can foretell unsuspected events, can direct us towards unforseen treasures of fact, and guide our researches in unexplored countries, it is only then that the value of his theories is put beyond doubt or cavil. This is well known in natural science, where the value of a theory is always gauged by its lead in the laboratory or in the field. In humanistic and historical science the honour of a prophetic voice has been reserved to its youngest off-shoot, anthropology. For though "history never repeats itself" when we watch it over a relatively brief span, interested in its detailed course of accidental happenings, yet the evolution of culture, taken as a whole, is submitted to definite rules and regularities, and human nature, broadly viewed, as it breaks through the media of various civilisations and stages of development, remains the same, and, being subject to laws, is thus capable of prediction.

The Golden Bough has had a triumphant career in this respect. One after the other the main supports of the lofty edifice, which at first might have appeared entirely carved out of the author's creative imagination, were traced to the solid bedrock of fact by subsequent discoveries among the backward races. The most fantastic feature in the ritual of Aricia, the succession by murder, led the author to the theory of the killing of divine kings, carried out by certain savages, in order to prevent their end by disease or senile decay. This theory, when first emitted, had only partial and meagre evidence in recorded fact. But the brilliant discoveries of Dr. and Mrs. Seligman about the divine kings of the Shilluk, about their violent end, regularly inflicted after a term of reigning, and about the spiritual succession by the transmission of the soul, confirmed Sir James Frazer's theoretical assumptions in every detail. Following this, field-work has brought, and is still bringing, fresh evidence, enough to prove that Frazer's researches have revealed an institution of the greatest importance among backward races.

Sir James Frazer was the first to express the view that before humanity had begun to worship spiritual beings there was a stage of belief and ritual, essentially magical, in which man assumed a fixed order of Nature, subject to the power of specific incantations and rites. Modern research among savages, in the measure as it penetrates more deeply into the comprehension of native ideas, tends to establish the correctness, not only of the general assumption of the magical stage in evolution, but also of Sir James's detailed theories of the psychology of magic. The nature of primitive kingship and power; the paramount rôle played by the taboo and its psychology; the importance of harvest ritual and ceremonies among savages—in all this it would be easy to show what copious results recent field-work has produced by following the suggestions and inspirations of the Golden Bough.

An irrefutable though somewhat external proof of this is to be found in the ever-increasing bulk of the book as it passes through successive editions, a score of new instances appearing to testify to the truth of some of Frazer's fundamental propositions, where previous evidence was able only to supply a few.

To mention only the other masterpiece of Sir James Frazer, "Totemism and Exogamy," we find again, after some thirty years, a small volume expanded into four large ones by the rich harvest of facts which followed the theoretical forecasts of the author. The ignorance of paternity, at first observed by Spencer and Gillen among one tribe only, was at once recognised by Frazer as of extreme importance for the early forms of totemic belief and organisation and kinship. Here again this forecast was confirmed, not only by further researches of Sir Baldwin Spencer in the north of Australia, but also by the discoveries of Dr. Rivers in the New Hebrides, and by the findings of the present reviewer among a number of Papuo-Melanesian tribes of Eastern New Guinea. There this ignorance is of extreme importance in shaping the matrilineal ideas and institutions of the natives, and is also closely connected with their totemism.

There seems to be some need of emphasising this empirical fecundity of the book—that is, its essentially scientific value. The great admiration which this work has inspired as a literary masterpiece and as a classic of comparative history, folk-lore, and archæology, seems to have overshadowed the merits of the book as an organiser and director of field-work. These merits are due, not only to the learning and to the constructive craft of Sir James, but also mainly to his genius in understanding the fundamentals of human nature, especially of the nature of primitive man, such as we see him represented by the peasant and the savage. In no other work can we find the same intimate understanding of savage modes of thought and behaviour, the same unfailing capacity to interpret the savage's customs, ideas, and traditions from his own point of view, the same prophetic intuition of what is really important with the native and what is secondary. It is because of that that no other work of anthropological theory has received such brilliant confirmation from later researches in the field, nor is any one of them likely to stimulate future research to the same degree as the Golden Bough.

To substantiate this last forecast I should like to indicate, on one more point, this suggestive quality of Frazer's theories. I mean the very *Leitmotiv* of the book, the importance of vegetable cults for primitive magic and religion, the enormous concern of primitive mankind for the soil's fertility and for its conditions, the sun, the rain, and the weather. Over and over again, in the course of the long and devious explanations of the ritual of Nemi, we meet with the magic of the skies and of the soil, with the worship of trees, with the belief in the influence of sex on vegetable fertility, with harvesting customs and superstitions, with Gods and Goddesses of the teeming forces of Nature.

The reader remains under the impression that the interest in the vegetable world has exercised an overwhelming influence over the formation of magical and religious belief and ritual; that these, like the luxuriant mantle of green which covers our earth, have grown out of the union of the skies with the earth's fertility.

This view, indeed, is not expressed by the author, who even, in the preface to this new, abridged edition, repudiates an extreme form in which this opinion has been imputed to him, the view, namely, that all religion starts from tree worship. "I am so far from regarding the reverence for trees as of supreme importance for the evolution of religion, that I consider it to have been altogether subordinate to other factors." This, of course, is quite true, but if, instead of tree worship, we take the wider complex of religious phenomena, the cult of vegetation, or rather of vegetable fertility and its conditions, I for one would fully endorse the view that here we have one of the very taproots of religious growth. I perceive, moreover, that this aspect of the Frazerian theories opens up new lines of empirical research of the greatest promise and importance.

The Golden Bough, in this regard, shows us primitive man as he really is, not an idle onlooker on the vast and varied spectacle of Nature, evolving by reflection a sort of speculative philosophy as to its meaning and origins, but an eager actor, playing his part for his own benefit, trying to use all the means in his power towards the attainment of his various needs and desires: supply of food, shelter, and covering; satisfaction of social ambitions and of sexual passions; satisfaction of some æsthetic impulses and of sportive and playful necessities. He is interested in all things which subserve these ends and are thus immediately useful. Round these he develops not only his material technique, his implements, weapons, and methods of economic pursuit, but also his myths, incantations, rites, and ceremonies, the whole apparatus of primitive science and superstition.

Among all forces of Nature useful to man, the earth's fertility occupies quite a privileged and special position in the mind of the savage. Vegetable life—in its perennial periodicity of active exuberance and relative rest in the tropics; of life and death in the cold and temperate zones; of barrenness and fertility in certain periodically irrigated deserts—exhibits a regularity and system, a dependence on causes and motives, which seem to be almost within the control of man, yet from time to time so baffling to all his endeavours as to keep his interests, hopes, and fears constantly alive. On this borderland, where man's self-sufficiency utterly fails him, yet where he perceives a clear order; on this ground, so vital to himself and so clearly subject to the play of some extraneous regularities or wills, here the ideas of magic and religion, always a cross-breed of reflection and emotion, flourish most abundantly. Especially where man begins actively to shape the forces of Nature in agriculture, magic ranges itself side by side with technical efforts and becomes a controlling factor of immense importance.

It would be natural to expect, therefore, that among savages there exists public magic of fertility, and that, on the sociological side, this leads to the early forms of chieftainship and kingship, while on the side of belief it leads to important developments of ritual and cult.

Here we touch on the sociological aspect of Frazer's theories of early magic. He clearly recognises the existence of a special class, who, by their magical knowledge, can acquire social importance: "the public magician occupies a position of great influence, from which, if he is a prudent and able man, he may advance step by step to the rank of a chief or king." The author further proceeds to show how very important these specialised magicians are, both in that they perform their services for the whole community, thus forming an integrating power, and also in that they are the first examples in the evolution of mankind of specialists freed from the ordinary burdens and occupations of their fellow-tribesmen, and able to devote themselves to one pursuit. The evidence which Sir James is able to adduce in support of his theory of public magic and of its sociological importance is great, but not quite adequate to substantiate all his theories. Thus, among the forms of public magic, Sir James can find examples only by referring to sunshine, rain, and weather. Even this material does not allow him to demonstrate in detail how political power and social influence arise from the exercise of the magical functions. We are led to inquire: If vegetable and fertility rites are so important, how is it that there are no departmental magicians of agriculture on record? Why does the public magician only control the conditions of fertility and not fertility itself? How can magical influence grow into political power? These questions seem at first sight to qualify and invalidate Frazer's theories of early kingship and magic. Yet here again, recent results of field-work among primitive people allow us to settle these doubts and cavils in a manner once more triumphant for the book, which shows itself to have been ahead of the material at the author's disposal.

In ethnographical researches done among some Papuo-Melanesian tribes of Eastern New Guinea, I found myself at once in the thick of a social and psychological situation such as is postulated by the Golden Bough. The office of the chief coincides there with that of the public magician. To the control of rain and sunshine the chief owes an enormous proportion of his executive power, which he uses to strengthen his position and to enforce his general will. A faithful disciple of the Golden Bough, I turned my attention to the institutions associated with agriculture. Then gradually I began to see that Frazer's theories of the sociologies of magic, of the rôle of the public magician, of the departmental control of natural forces, rested on much more solid foundations than he himself had been able to realise with the material in hand, and that this can be demonstrated on the book's own territory, that of vegetable cults. For not only do there exist in these tribes departmental magical rites of fertility, not only are they the most important ones, ranking even before the weather rites and always carried out by the chief, but also we can study there the sociological mechanism by which the garden magician obtains his political power.

In each community we find a garden magician, who performs his ritual for public benefit. These functions are always vested in the headman of the community. In villages which are capitals of a district and governed by a chief, he himself carries out the magic of vegetation. In this rôle, the headman or chief commands not only a high respect, as the man who has in his hands the forces of fertility and who knows how to tap them, but he also takes an actual lead in the practical pursuits accompanied by the magic. For the magical ritual is intimately bound up with the technical activities. It imposes a regularity in time, and compels people to work in order and in organised groups. This refers to several forms of public magic, such as canoe-building, fishing, and overseas expeditions, but most conspicuously to garden magic. In this, the magician controls the work of the whole community during the course of the year, gives the initiative to the various stages, has the right of reprimand and punishment, is regarded as the man responsible for success and failure, and receives tributes from his fellow-villagers.

Here again we see that, starting from one of those theories of the Golden Bough which go far ahead of the available evidence, field-work reaches interesting and important discoveries. In this case it leads to the study of primitive economics, a chapter very much neglected by the traveller and amateur ethnographer, and even by the specialist, which promises, however, to yield results of some importance. For I have no doubt that my confirmation of Sir James's theories from a limited ethnographical area will be followed by other more important discoveries all the world over.

Thus the Golden Bough, far from being a classic in the sense of having attained the fulness of its glory and deserving honourable rest, is a book which still has some hard service in the field before it, a book which should be n the kitbag of every ethnographic explorer. A modern ethnographer, in his researches among savages, must, while making his observations, remain still in contact with theoretical literature in order to receive from it constant inspiration and guidance, especially if he is bent on doing intensive field-work, if he is willing and able to remain for months and years among the same tribe and study it by means of their own language and by personally taking part in the tribal life. In such study I derived constant inspiration and benefit from the works of Westermarck, Karl Bücher, Ratzel, Marett, Hubert and Mauss, Crawley and Rivers, some of which I actually have re-read while in the field, others again in the intervals between my expeditions. Alas! at that time the twelve volumes of the Golden Bough were too heavy and costly a burden to carry across sago swamps, to paddle over lagoons in an outrigger always ready to capsize, or to keep in a tent or thatched hut by no means rain- and insect-proof. Now the more fortunate field-worker can easily take with him, handle, and constantly refer to the new, one-volume, abridged edition.

To the student in his library, this abridged edition will no doubt only serve as a handy guide, as a sort of explicit digest, or to the beginner as a preliminary introduction. The full version is indispensable to the student, and it is also the most fascinating and instructive reading to the layman. But no doubt many a one who was at first shy of tackling directly the Golden Bough will, in the short edition, find a bridge to the full work, which is not only the most important achievement of Sir James Frazer, but also the last word of modern anthropological scholarship.

B. Malinowski.

Modern Cosmogony.

The Nebular Hypothesis and Modern Cosmogony: being the Halley Lecture delivered on May 23, 1922. By J. H. Jeans. Pp. 31+4 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 2*s*. 6*d*. net.

DR. JEANS'S analysis of the modes of rupture of fluid masses under the influence of excessive rotation or of the gravitation of other bodies, earned him the Adams prize of the University of Cambridge in 1917 and the gold medal of the Royal Astronomical Society in 1921. The results appeared in his "Problems of Cosmogony and Stellar Dynamics," published in 1919. The relation between his book and the pamphlet under review is that while the book was a theoretical work with an observational commentary, the Halley lecture is an account of observations with a theoretical commentary.

The Laplace-Roche theory of the development of a rotating and condensing gaseous mass showed that it would be flattened at the poles, and, if strongly condensed towards the centre, it would ultimately become lenticular, with a sharp edge. The next stage was believed to be that this edge would open all round, and the matter would pour out to form a ring. The rings of Saturn were claimed as an example of this process, but it is now known that they could never have passed from the gaseous to the solid state if they had been first produced in this way at their actual distance from the planet. The heavens have been searched for other bodies showing rings of Laplacian type, but none has been found.

Numerous nebulæ, however, show the flattened and lenticular forms indicated by the early stages of the theory, and Jeans considers that they are true examples of it. Other nebulæ show lenticular centres, with definite indications of detached matter around the equatorial sharp edge, and the more of this matter there is, the clearer does it become that it is not in the form of a ring or series of rings, but of spiral arms. In fact, known nebulæ afford examples of every intermediate stage, from the flattened symmetrical mass, through the lenticular form, to the typical spiral nebula, and it is difficult to resist the conclusion that this gradation corresponds to an actual course of evolution. This evidence is beautifully presented in the published lecture.

Although the astronomical evidence for such a phenomenon is strong, it calls for a dynamical explanation. We need to know why the matter is ejected almost entirely at two opposite points and not uniformly all around the equator. Jeans suggests, with much plausibility, that the equator would be distorted by the gravitation of surrounding bodies, and that, however small the distortion was, it would suffice to localise the ejection at two opposite points, and hence two arms would be formed instead of a ring.

Van Maanen, at Mount Wilson, has measured the motions of identifiable parts of spiral nebulæ. The motion is curious. The arms are approximately equiangular spirals, and the matter constituting them is moving outwards along the arms, its velocity increasing the farther it recedes from the nucleus. The nucleus is rotating with the arms. Now, this motion is just what Jeans deduced from theoretical considerations, taking into account the viscosity of the mass. The time of rotation of the nebula, and the velocities found spectroscopically, together give an estimate of the distance of the nebula M. 33 as 2000 parsecs, and of its diameter as 30 parsecs. The mass of the whole is about 100,000 times that of the sun. The nebula in Andromeda probably has a mass 20,000,000 times that of the sun.

The velocity of the arms of M. 33 is such that the whole of the visible matter must have been within the nucleus 200,000 years ago; and as we must suppose that the nebula is older than this, matter must be continually ejected. Jeans gives strong ground for believing that it condenses to form stars of mass comparable with the sun.

The method of rupture of much denser and smaller masses is next considered. Jeans has already shown that a star will break up into two fragments comparable in mass if it rotates sufficiently rapidly. Some double stars show such light variations and velocities in the line of sight as indicate that they are in close contact, agreeing with the hypothesis that they have just been formed by the fission of a single star through excessive rotation. Their periods of revolution and their spectral type (B) agree with further predictions of the theory. In some cases a stationary calcium atmosphere surrounds both components; this is readily explicable as the original atmosphere of the star, which has not yet attached itself to either component, but will divide into two when the components get far enough apart.

The last few pages give a short summary of the tidal theory of the origin of the solar system. The disruption of the sun by the tidal action of a passing star is supposed to have led to the formation of the planets. Jeans considers that such an event may have happened to some other stars, but that these constitute only a small fraction of the stars we know. The majority of the stars are probably unattended by planets, and perhaps the earth is the only body in the universe capable of supporting life.

Harold Jeffreys.

Military Mining.

The Work of the Royal Engineers in the European War, 1914–19. Military Mining. (Published by the Secretary, Institution of Royal Engineers, Chatham.) Pp. x+148+61 plates. (Chatham: W. and J. Mackay and Co., Ltd., 1922.) 12*s.* 6*d.* (7*s.* 6*d.* to members of the I.R.E.)

The volume before us describes a most arduous branch of the work that the Royal Engineers were called upon to carry out in the War—a branch, the final success of which was largely due to the technical skill of civilian coal-miners from Great Britain working under mining engineers from the Colonies and abroad.

The book is divided into three sections dealing with (1) the history of mining during the major operations of the campaign, (2) mine rescue work, and (3) technical considerations.

At the end of the first battle of Ypres "the study and practice of military mining were suddenly revived by the discovery that stationary trench systems brought back all the old features of fortress warfare." Before the end of 1914 at least two mines were exploded by the enemy under our trenches. This caused a demand for special mining units, and in February 1915 the first party of British miners arrived in France. By the end of June 1916, operations had extended so much that a total force of 25,000 men was employed in this work, and during that month no less than 227 mines were blown on the British front, 101 by us and 126 by the Germans.

The greatest of many successful mining achievements during the war was the deep-level attack at Messines on June 7, 1917, when on a narrow front and in the space of 30 seconds mines were fired containing nearly 1,000,000 lbs. of high explosive. "The moral effect of these explosions was simply staggering," writes General Ludendorff in his Memoirs, and he attributes to them the success of our attack. This scheme was remarkable also for the long period of preparation (it was begun in the previous summer) and the consequent anxiety lest its extent should become known to the enemy. A month before the attack they were clearly heard in deep workings at Hill 60, but it was correctly calculated that their gallery would just pass clear over ours, and they were allowed to go on working.

In addition to offensive mining an immense amount of work was done by tunnelling companies in the construction of dug-outs, communication tunnels, and road repair, and during the summer of 1918 in the removal of mines and traps left by the enemy as they retired.

Owing to the number of casualties in the early days of mining, chiefly caused by carbon monoxide from the detonation of high explosives, rescue work became of great importance, and was effectively organised under Lieut.-Col. D. Dale Logan. The next step was the formation in 1916 of a special medical service for tunnelling companies, all the officers of which had been for years in mining practice. A well-deserved tribute is paid to the work of these officers and of the rescue men, whom it was found necessary to select with the greatest care owing to the very trying nature of their work.

The apparatus and methods used are described at some length. It is worthy of note that "with small exceptions there appeared to be a total absence of any regular mine-rescue organisation along the whole German front."

In the technical section of the book a large amount of information is given on such subjects as disposal of spoil, listening instruments, and the work of the mine schools. It also discusses the main principles which gradually became evident as underground warfare developed, the most important of which may be summed up in the statement that "the best form of defence is attack." By a strenuous application of this idea "the enemy was reduced underground by the autumn of 1917 to a state of absolute passivity on the entire front."

Our Bookshelf.

Encyclopædia of Veterinary Medicine, Surgery, and Obstetrics. Edited by Prof. George H. Wooldridge. In 2 vols. Vol. 1: *Veterinary Medicine.* Pp. xiv + 546 + xxiii. Vol. 2: *Surgery and Obstetrics.* Pp. viii + 547-1106 + xxx. (London: H. Frowde and Hodder and Stoughton, 1923.) 2 vols., 6*l.* 6*s.* net.

To describe this work as an encyclopædia is a little misleading. It comprises two volumes, the first of which deals with veterinary medicine and the second with veterinary surgery and obstetrics, but they are distinguished from what are commonly called text-books on the same subjects only by the fact that a large number of authors have collaborated in their production. The preface expresses the hope that the work will be found useful to veterinary students, owners of animals, and members of the medical profession, as well as to the general veterinary practitioner; but it is obvious that the guiding consideration in the production of the work has, quite rightly, been the requirements of the practising veterinary surgeon.

No veterinary work on exactly the same plan has previously been published in Great Britain, but it may safely be said that as a practical and scientific treatise it is superior to any of the previous English text-books on the same subjects. In a work to which more than thirty authors have contributed, absolute uniformity in style and other qualities of the different sections is not to be expected, but for the most part the language is clear and concise, and the information is up-to-date. A notable defect, especially marked in the first volume, is that the amount of space devoted to different diseases appears to bear no close relationship to the importance of the subject. It seems impossible to imagine any good reason for allowing seventeen pages to horse-sickness, which is a purely African disease, and six pages to snake-bite, while tuberculosis is only allowed ten pages, and glanders, epizootic abortion, foot-and-mouth disease, and rabies together occupy only sixteen pages. The value of many of the articles is enhanced by good illustrations, and the publishers' share of the work has been well done.

Archives de morphologie générale et expérimentale. Fascicule 14 (*Morphologie expérimentale*): *Le Déterminisme et l'adaptation morphologiques en biologie animale.* Par Prof. R. Anthony. Première partie: *Déterminisme morphologique et morphogénie.* Pp. 374. (Paris: Gaston Doin, 1922.) 28 francs.

This work is an attempt to describe the form and structure of animals in so far as they can be shown to be determined by morphogenetic factors in the environment. The author begins with generalities about life, evolution, and variation, sketches the history from the earliest times of a rational explanation of morphology, upholds the Lamarckian doctrine with the usual inconclusive arguments, and incidentally places the Emperor Julian as a precursor of Lamarck. Thence he passes to the description of observations and experiments on the effect of external factors on structure, more especially in molluscs and vertebrates.

Although there appears to be little in this account which is actually new, yet Prof. Anthony has brought together a number of interesting facts showing how closely structure is correlated with function—how, for example, the shape and size of muscles and the relative lengths of muscle fibres and tendons are regulated according to the motions to be executed, also the shape and internal structure of bones. It follows that in many cases they can be altered experimentally.

These observations, however, seem to us to prove, not that the Lamarckian theory of evolution is correct, but that organisms are the products of the interaction of the physical basis of heredity with the environment in which they develop. This fundamental conception, long ago appreciated by the botanist with regard to plants, is still but imperfectly understood by the zoologist.

Department of Scientific and Industrial Research. Memoirs of the Geological Survey. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1921, *with Report of the Geological Survey Board and Report of the Director.* Pp. iv + 189. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1922.) 5*s.* net.

For many years past, geologists who wish to keep pace with research in the stratigraphy or petrology of our islands have found that they must not overlook the annual volumes modestly entitled "Summary of Progress of the Geological Survey." The issue for 1921 contains a paper by E. E. L. Dixon on "The Retreat of the Lake District Ice-Cap," and the formation of fluctuating lakes held up by glacier-dams. The relations of kames and outwash-mounds of various kinds are considered, and the protruded products of sub-glacial melting, where clearly connected with a "feeding esker," are well styled "esker deltas." Foreign geologists may be puzzled at the frequent occurrence of the name of Lamplugh in a glacial paper as that of a village at the foot of Owsen Fell. On p. 129, Dr. R. Kidston provides a new example of how the determination of the species of Carboniferous plants enables the "practical man" to determine the horizons of his coal-seams. The lists of species from the beds now shown to be Westphalian in the Durham and Northumberland Coalfield contain some revisions of genera, and several new forms are mentioned. May we suggest that the printing of the titles of such papers on the cover of the "Summary of Progress" would do much to bring the publication into line with the convenient bulletins of the United States Geological Survey? G. A. J. C.

Comparative Ethnographical Studies, 5: Deductions suggested by the Geographical Distribution of some Post-Columbian Words used by the Indians of S. America. By Erland Nordenskiold. Pp. xiv + 176. (London: Oxford University Press, 1922.) 18*s.* 6*d.* net.

THE fifth volume of Baron Nordenskiold's valuable series of Comparative Ethnographical Studies deals with the distribution of words used by the Indians for certain post-Columbian elements in their culture—the domestic fowl, horses and cattle, the banana, iron, firearms, scissors—and certain partly post-Columbian elements—European knives, needles, and fish-hooks. Of these words some are of Spanish or Portuguese derivation, others are of native invention and are onomatopœic, as sometimes for the fowl, or purely descriptive.

The author's main interest lies in the historical deductions to be drawn from the distribution of these words. It affords clear evidence, not only of the course of the diffusion of culture, but also of trade routes and of tribal migrations. In many instances, confirmation is afforded by comparison with the accounts of the early chroniclers. It is interesting to note that European culture elements had reached the Aymara and Quichua from the East before Pizarro came into contact with them from the West. This valuable contribution to the history of the Indians of South America in post-Columbian times will cause students of South American civilisation to look forward with eager anticipation to the author's promised study of pre-Columbian culture on similar lines.

The Industrial Applications of X-rays. By P. H. S. Kempton. (Pitman's Technical Primers.) Pp. xiii + 112. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

MR. KEMPTON'S little book gives a good introduction to "radiomateriology," that is, to the examination of materials by means of X-rays. The art has made great strides since the War, and by means of the powerful high voltage apparatus now employed, steel forgings and castings several inches thick can be satisfactorily tested. Examination by X-rays is of particular value for detecting flaws in metallic products and for examining welds and joints made by brazing or soldering. It is also specially useful for examining timber, reinforced concrete, electrical insulating materials, and precious stones. The author describes the apparatus used in industrial radiology and gives interesting radiographs. Complete installations for the X-ray examination of materials are described, and due stress is laid on the importance of protective screens and safety devices. In the table of spark-gap voltages given, it is interesting to note that for a given spark-gap the disruptive voltage increases with the size of the spherical electrodes up to a certain value and then diminishes for larger electrodes. This is in accordance with theory.

Inca Land: Explorations in the Highlands of Peru. By Hiram Bingham. Pp. xvi + 365 + 45 plates. (London: Constable and Co., Ltd., 1922.) 24*s.* net.

IN this volume Prof. Bingham describes a part of the work accomplished by the four expeditions of Yale University and the National Geographical Society to Peru between the years 1909 and 1915. Where so much is new and of absorbing interest it is difficult to select any one discovery as outstanding; although in archæology most will, no doubt, agree that the exploration of the ruins of Machu Picchu has been the most important in its results. This site, with its magnificent and, in some respects, unique architectural remains, is held by the author to be probably the Tampu Tocco to which the pre-Inca people, the Amautas, retired when the country was invaded from the south about A.D. 800, and from which the first Inca, Manco Ccapac, began to extend his Empire about A.D. 1300. Fascinating, too, is the story of the search for Uiticos, the lost stronghold of Tupac Amaru, the last of the Incas, defeated and killed by the Spaniards in 1572, and for the "white rock over a spring of water," the site of the Temple of the Sun burnt by two zealous Spanish friars in 1568. The results obtained by these expeditions were little short of remarkable, and have added enormously to our knowledge of the geography, archæology, and natural history of the country.

Laboratory Manual of Physical Chemistry. By Prof. Albert W. Davison and Prof. Henry S. van Klooster. Pp. viii + 182 + 32 pages of sectional paper. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 10*s.* net.

THIS "Laboratory Manual of Physical Chemistry" covers only twenty-four experiments, but these are set out in detail with full references to the literature. An ample supply of blank pages is provided, together with ruled spaces for filling in experimental data; tables of atomic weights, densities, vapour-pressures, and refractive indices are also given, with logarithm-tables and a sufficient supply of squared and triangulated paper to provide for the whole of the experiments suggested. The manual, therefore, becomes the student's note-book as well as his text-book, and will enable him to place his own results on his bookshelf in a more orderly manner than is usual.

Causes and Consequences. By Sir Bampfylde Fuller. Pp. x + 291. (London: J. Murray, 1923.) 12*s.* net.

THE author of this book discourses on many things, indeed, on all things which concern science and philosophy, with an easy-flowing style and irresponsible dogmatism. His description of insects as "brainless animals" has already evoked a lengthy correspondence in the Press, and he might easily be called to account for a hundred other equally confident and artlessly simple-minded statements. Thus, for example, he tells us "it seems clear that some of the theories connected with the name of Professor Einstein are based upon a confusion of time and space with rhythm."

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.*]

Adsorption and Hæmoglobin.

As I have in other places entered a plea for more consideration of the possibility that adsorption may play some part in the phenomena of the taking up of oxygen by hæmoglobin, a few remarks on the letter by Mr. N. K. Adam in NATURE of April 14 may be permitted me, chiefly with the object of making clear my attitude in the matter. It is briefly this. Nearly all, if not all, of the workers on the problem direct their attention only to the investigation and interpretation of these phenomena from the point of view of mass action in a homogeneous system. Now, while this may ultimately turn out to be the correct view, it must not be overlooked that hæmoglobin under most conditions exists in the form of colloidal aggregates. Thus, surface phenomena may intervene and should receive due consideration, even if only to be put on one side. This has not been attempted to any serious extent, since Wo. Ostwald showed that the data of the taking up of oxygen by hæmoglobin could be expressed by an adsorption formula. It is true that such a formula, as Mr. Adam says, contains two arbitrary constants, and fitting it to the experimental data does not prove anything as to the nature of the phenomena. But the same statements may be made with regard to the widely accepted Barcroft-Hill expression.

Any criticism that I venture to make is not to be understood as doubting the value of the data that are being obtained, but rather as directing attention to certain gaps in our knowledge which require to be filled up before further progress in the interpretation of the facts can profitably be made. There is, as it seems to me, some risk of building elaborate hypotheses on assumptions which are not clearly demonstrated. It appears sometimes that workers are so convinced that the mass action view is all that is necessary, that they are not interested in testing the truth of these assumptions. If it is found that an experimental result can be explained on the lines of mass action formulæ, however elaborate, it is taken as confirming the view; but other hypotheses might be found equally well to satisfy the case, if seriously examined. Compare, for example, Langmuir's formulæ for the adsorption of a gas by a crystal surface with the Hill-Barcroft formula. I am sometimes inclined to wish that it were possible for an investigator who knew nothing about previous theories to attack the problem as a new one.

But to be more precise—it is undoubtedly a very important fact that when hæmoglobin has taken up all the oxygen that it can, this oxygen is in the proportion of one molecule to each atom of iron in the molecule of hæmoglobin. It is natural to believe that the iron and oxygen are directly united. Mr. Adam's assumption that the oxygen is "locally attracted" rests on this belief. Are we quite certain that it is the case? And even if it were, we know too little about the forces which bring about adsorption to be able to exclude the possibility of local foci, as it were. On the view of chemical combination, in the strict sense, between oxygen and iron, is not the greater affinity of hæmoglobin for carbon monoxide than for oxygen rather puzzling? There is also the problem of methæmoglobin, another compound of hæmoglobin and oxygen, but one which does not give up its oxygen to a vacuum. I have not been able to find in the literature dissociation curves of oxyhæmoglobin continued beyond the saturation point in the presence of excess of salts or of carbon dioxide. On the purely chemical theory, with sufficient concentration of oxygen, the saturation point should still be in the same proportion of iron to oxygen. In connexion with the relations between hæmoglobin and carbon dioxide, no proof has yet been given that the union is of a different nature from that with oxygen. It is still uncertain whether the hæmoglobin that combines with carbon dioxide is a sodium salt.

To put the question in another way—does hæmoglobin free from sodium combine with carbon dioxide, or does it not? But if hæmoglobin, as worked with, is a sodium salt, osmotic pressure measurements give no direct information as to the molecular weight of hæmoglobin. It appears to be accepted by most of those working on the problems that oxyhæmoglobin is a much stronger acid than hæmoglobin itself. It is true that to explain the carriage of carbon dioxide by mass action formulæ, this is necessary. But is it impossible to put the question to more satisfactory experimental test than has yet been done? Again, the cause of the widely divergent results obtained by different investigators of the heat of combination between oxygen and hæmoglobin has not been adequately made out. While, therefore, the data which are being accumulated in so many places are of the greatest value in relation to the actual behaviour of hæmoglobin under certain conditions, I find it impossible to interpret them on the basis of any theory until the questions above mentioned are answered.

A subsidiary point, but one about which agreement is desirable, is the use of the name "polymerisation" in place of the more usual one, in relation to colloidal behaviour, of "aggregation." It would be of advantage if clear definition of these terms, together with that of "association," could be agreed upon.

It is perhaps to the point to recall those processes which obey the unimolecular law as deduced from mass action, at all events in a part of their time course, although we know that as a whole they are much more complex than simple chemical combinations.

Turning to Mr. Adam's criterion of adsorption, I agree that it is impossible to define it by the nature of the forces concerned. It seems to me, however, that it is only shown when a sufficient number of atoms are joined to form a surface. To adopt the criterion of the whole surface becoming uniformly covered when the concentration rises to a certain value, neglects, I think, those cases where two or more substances are adsorbed simultaneously. Mr. Adam appears to accept Langmuir's views. While these explain many cases, there are others where the range of the forces concerned extends beyond one molecule. According to Evans and George (Proc. R.S., A, 103, p. 192) the thickness of the layer of carbon dioxide on glass amounts to that of five or six molecules. Chemical forces in the ordinary sense seem to be excluded here. Moreover, accepting the probability of orientation on an inert surface, like that of charcoal, by affinity of certain groups for the water of the liquid phase, it is difficult to see how the increased concentration itself is initially brought about. But, after all, is it not rather an idle discussion to make definite distinctions between chemical and physical forces in the region of atomic properties? Does not the Braggs' crystal model indicate that the forces responsible for cohesion, chemical union, and electrical behaviour are one and the same? The recent discovery that in the crystal of beryllium acetate an oxygen atom has four *equal* valencies suggests also a reconsideration of the doctrine of "residual valencies," as used by Langmuir in his theory.

W. M. BAYLISS.

April 30.

The Complex Anisotropic Molecule in Relation to the Theory of Dispersion and Scattering of Light in Gases and Liquids.

OBSERVATIONS by Cabannes,[1] the present Lord Rayleigh,[2] Gans,[3] and others have shown that the light scattered by various gases in a direction at right angles to the incident beam is not completely polarised. This is accounted for by Cabannes in terms of a *simple anisotropic molecule* of the type first used by Langevin [4] in 1910 to account for electric and magnetic double refraction. Such a molecule contains a single dispersion electron acted on by unequal quasi-elastic restoring forces along the principal directions and capable of vibrating with three different frequencies.

The present writer has extended the theory to gaseous and liquid media composed of *complex anisotropic molecules*, in which there are any number of dispersion charges the principal directions of which are not parallel. For an isotropic medium in which all molecular orientations are equally probable, a general dispersion formula of the Lorentz type is derived.

In *gaseous media*, owing to rapidly varying changes of position, each molecule contributes independently to the *intensity* of the scattered radiation. For unpolarised incident light of intensity I, the *depolarisation* is measured experimentally as the ratio of minimum to maximum intensity when the light scattered at right angles to the incident beam is examined by a Nicol prism, and as observed in gases is a quantity characteristic of the molecule. The intensity $I_s\theta$ scattered in a direction θ with the incident beam of wave-length λ, to a distance r from a volume $\bar{V}$ is given by the formula

$$\frac{r^2 I_s\theta}{\bar{V}I} = \frac{1}{2}\frac{\pi^2}{\lambda^4}\frac{(\mu^2-1)^2}{n} \cdot \frac{6(1+\rho)}{6-7\rho}\left\{1+\frac{1-\rho}{1+\rho}\cos^2\theta\right\}, \quad (1)$$

where μ is the refractive index corresponding to molecular density n.

The corresponding formula for the coefficient of extinction by scattering is

$$K = \frac{8\pi^3}{3\lambda^4}\frac{(\mu^2-1)^2}{n} \cdot \frac{6+3\rho}{6-7\rho}. \quad . \quad . \quad (2)$$

A remarkable feature of these formulæ is their *invariance* with respect to such details of molecular structure as number and magnitude of dispersion charges and mutual orientation of principal directions.

In *liquids*, from the observations of Martin,[5] Lord Rayleigh, Kenrick,[6] Raman,[7] and others, it is now definitely established that dust-free liquids are able to scatter light. According to Smoluchowski [8] and Einstein,[9] the explanation of this phenomenon, first observed near the critical point of a liquid, lies in fluctuations of molecular density due to thermal agitation. Since a volume of linear dimensions small compared with a light-wave contains several million comparatively stationary molecules, it is necessary in dealing with liquid media to sum the components of the electric vector in the scattered light-wave from each molecule. In these circumstances, it may be shown that equally probable orientations of complex anisotropic molecules within this small volume would result in the scattered light being completely polarised, contrary to observation. It is concluded, therefore, that *liquids have an extremely fine-grained crystalline structure*, the crystalline aggregates being supposed to be incapable of withstanding stress owing to molecular vibrations, and to be continually breaking up and re-forming under the influence of these elastic waves, which according to Debye's [10] theory constitute the energy of thermal agitation. If we suppose the energy of one degree of freedom to be associated with the random pulsations of these crystalline aggregates, we derive instead of (1) the following formula for scattering,

$$\frac{r^2 I_s\theta}{\bar{V}I} = \frac{1}{2}\frac{\pi^2}{\lambda^4}(\mu^2-1)^2\frac{6(1+\rho)}{6-7\rho}\frac{RT\alpha}{N}\left\{1+\frac{1-\rho}{1+\rho}\cos^2\theta\right\}, \quad (3)$$

where, in addition to the symbols already defined, R is the gas-constant per gram molecule $=83{\cdot}2 \times 10^6$ C.G.S., N is Avogadro's constant $=6{\cdot}06 \times 10^{23}$, T is the absolute temperature, and α is the *adiabatic* compressibility.

As in the case of the preceding formulæ, (3) enjoys the property of invariance with respect to details of molecular structure, and it is derived on the hypothesis that the molecules in each crystalline aggregate are not greatly disturbed from perfect alignment by angular oscillations which result in a diminution of the depolarisation ρ as the critical point is approached, as has, in fact, been recently observed by Ramanathan [11] in the case of liquid ether.

For light scattered at right angles to the incident beam, Martin has shown that the inverse fourth power law holds good for benzene and water. For $\lambda=4358$ Å. and 20° C., we find for $r^2 I_s(\frac{1}{2}\pi)/(\bar{V}I)$ the following comparisons,

Benzene	$21{\cdot}5 \times 10^{-6}$ (calc.)	$26{\cdot}0 \times 10^{-6}$ (obs.).
Water	$1{\cdot}85 \times 10^{-6}$ (calc.)	$1{\cdot}77 \times 10^{-6}$ (obs.).

Formula (3) also accounts theoretically for the relative scattering of some twenty organic liquids studied by Martin.

This satisfactory agreement between theory and observation goes far to justify the hypothesis of the crystalline structure of liquids as just described. To this view strong support is lent by the observations of Debye,[12] Keesom,[13] and more recently of Hewlett,[14] on the scattering of a beam of X-rays by various liquids.

Although the results thus far have been based on a general type of "static" molecule, the theory is by no means opposed to the modern conceptions of the "dynamic" atom. For wave-lengths long compared with molecular dimensions, we may suppose those perturbations which contribute principally to dispersion to consist of forced oscillations of each atomic system of electrons with respect to the corresponding positive system.

LOUIS V. KING.

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The Adhesive Apparatus of the "Sucking-fish."

It is regarded in text-books[1] as a well-established fact that the adhesive organ of the "sucking-fish" (Echeneis and Remora, etc.), and a somewhat similar structure in Pseudecheneis and certain other freshwater fish, functions as a "sucker"; in other words, it enables the fish to adhere by the creation of a vacuum, or at any rate a partial vacuum, between the ridges and the rim of which it is constituted. Observations on Pseudecheneis and its allies in natural conditions led both Dr. Annandale and myself to doubt whether this belief is well founded.

It is very significant that, as several observers have noted, Echeneis can be detached from its hold quite easily by either thrusting it forwards or sideways,[2] while the so-called rim of its adhesive apparatus is entirely absent as a raised ridge in fresh material or well-preserved specimens. The whole structure,[3] moreover, differs in almost every respect from the true sucking disc present on the lower surface of the fish Garra[4] (Discognathus) and of the tadpoles[5] of *Ranæ Formosæ*.

I have recently had an opportunity of conducting experiments on the living Pseudecheneis, and have also had the great advantage of being able to consult Prof. C. V. Raman on the physics of adhesion both in this genus and the true Echeneis. We are convinced that the apparatus of these species, unlike that of Garra and the tadpoles mentioned above, is not a true sucker but essentially an elaborate device for producing the maximum amount of friction. It is correlated in a very interesting way with the shape of the fish. The upper surface of Echeneis and the under surface of Pseudecheneis are flattened to increase frictional area, while the lower surface of the former and the upper surface of the latter have adopted such a form that an advantage is taken of the swift current, which, instead of dislodging the animal, presses it against the substratum. The pressure exerted by the current increases friction, for friction is proportional to two factors—the coefficient of friction and pressure. The coefficient of friction is increased by the presence of a large number of strong spines, all of which are directed backwards on the lamellæ of the pad of Echeneis, and by innumerable microscopic epidermal spines[6] found on the ridges of the adhesive discs of hill-stream fishes. The plates bearing the spines in Echeneis point posteriorly, with the result that the spines come into action against the opposing surface when the fish is pressed backwards by the current, but are released when the movement is in the opposite direction. The enormous difference in the frictional coefficient for forward and backward movement is easily noticed when a finger is passed over the pad of a preserved specimen of Echeneis. It is also possible that the ridges and grooves in these fishes assist in increasing friction much in the same way as the ridge- and groove-patterns to be found on the tyres of motor cars.

Echeneis can cling to smooth surfaces in the absence of currents.[7] The strong spines on the lamellæ are quite sufficient to render this possible, and the phenomenon is not at first sight so remarkable as the power of adhesion in opposition, as it seems, to a strong current.

This note is written chiefly with the object of bringing this new view of the mechanism of the so-called sucker to the notice of other workers, particularly of those who are in a position to make observations on living specimens of Echeneis, Remora, etc. I hope myself shortly to undertake fuller studies of the morphology and histology of the adhesive pad with the view of elucidating the subject further.

SUNDER LAL HORA.

Indian Museum, Calcutta, March 29.

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[7] Hornell, Madras Fisheries Bull., XIV., pp. 66 (1921).

Vertical Change of Wind and Tropical Cyclones.

In his article on the birth and death of cyclones (London Meteorological Office, Geophysical Memoirs, No. 19, 1922) Sir Napier Shaw makes the interesting suggestion that the shearing of the head of a tropical cyclone with reference to its foot, by difference of velocity at different levels in the air which carries it, might cause its dissolution. If the hypothesis that the movement of a cyclone is due to its being embedded in a flowing current of air is correct, it will of course be admitted that if there is a considerable gradient of wind upwards, positive or negative, then there must be a continual shearing of the cyclone and the shearing must either be continually countered by the cyclone, or it must die. But the question is, whether there are occasions when a cyclone has to face such a strong vertical gradient of wind, and if there are, what vertical gradient a cyclone can stand and continue to live? With regard to the first point, from an examination of the symmetry of temperature and pressure Sir Napier Shaw remarks:

"If isobaric surfaces are also isothermal surfaces there is no change of wind velocity with height. In any case one would have to assume approximate uniformity of direction and speed for a thickness of several kilometres, in order to get a definite connected body of air in stable motion. Perhaps for the levels between four and eight kilometres there are enough occasions of little change of wind velocity between those levels to furnish convenient circumstances for the persistence of a sufficient number of cyclones or cyclonic depressions."

The atmospheric conditions in the region surrounding a cyclonic depression are so different from those of normal weather, that it is perhaps quite incorrect to assume that the vertical gradient of wind, which a cyclone has to encounter, is roughly of the same order as the gradient derived from the observations of the motion of pilot balloons under normal conditions. As pointed out by Sir Napier Shaw, it is also a matter for careful consideration, what is actually presented to us by the motion of a pilot balloon in a cyclonic depression. The irregularities due to local turbulence or the changes incidental to an inclined axis will appear in the results with as much weight as the examples of fundamental structure. Perhaps the altered condition of the atmosphere in which a fully developed cyclone finds itself does not permit of too much change of wind velocity with height, and then all our conjectures regarding the supposed effect of a vertical gradient of wind on a cyclonic system will appear futile.

If a cyclone is to be considered a stable dynamical system consisting of a vortex with a ring of maximum velocity, as Sir Napier Shaw considers it to be, and "protected from the ordinary vicissitudes of weather by the *enormous momentum* of a vortex with a high rate of spin," then as a vortex will generally, except perhaps for the fact that air is not a perfect fluid, form a closed system or end on boundaries, we shall have to assume that in a cyclone the dynamical conditions extend from the ground surface to considerable heights. Perhaps also the entire length of the vortex and not simply the length where the sustaining energy is supplied is effective in offering resistance to extraneous forces, because the energy wherever it is supplied will distribute itself over the entire length. The high degree of permanence of the type of motion is also suggestive that its enormous momentum does offer considerable resistance to all forces of destruction. A small vertical gradient of wind, if there is such a gradient at all, will therefore probably not shear a cyclone out of existence. It will perhaps deform the cyclonic system or make its axis inclined to the vertical; but if the gradient is considerable and of long duration, and if the struggle to maintain its circulation and to remain reasonably erect proves too much for the cyclone, it will eventually die.

The possibility of the axis of a cyclone being inclined to the vertical has long been surmised, and Sir Napier Shaw himself has advanced arguments attempting to give definiteness to the meaning of this idea ("Manual of Meteorology," Part IV., p. 145). It should, however, be remarked that the axis of a cyclone being inclined to the vertical will have a definite meaning only if the whirl is supposed to extend to heights comparable to the diameter of the core and not simply to 3 or 4 km., that is, only a little beyond the levels where the sustaining energy is supplied, as suggested by some meteorologists, including Eliot and Dallas.

If, on the other hand, we do not consider the cyclonic system and the flowing current, if any, as two distinct systems, and seek for an explanation of the movement of cyclones in the mechanism of the cyclonic system itself, then the consideration of the shearing of a cyclone due to a vertical gradient of wind does not arise at all. Consider, for example, the storms which form in the Indian seas. The centrifugal force in these storms, especially at the outer margin, is not strong enough to keep the monsoon winds feeding into them revolving in a circular path, with the result that these winds after taking a small turn deviate from the circular path and carry the cloud ahead of the storms. The precipitation and the consequent latent heat set free in front of the storms reduce the pressure there, necessitating a readjustment and a shifting of the isobars. This will in general account for the movements of these storms. It is, of course, implied in this explanation that it is not the general drift of winds that makes a cyclone move, but that the movements of the cyclone involved in its mechanism make the outlying winds adjust themselves to the motion.

S. K. BANERJI.

The Observatory, Bombay, March 27.

A Levitated Magnet.

PRESUMABLY all interested in magnetism have tried to keep a magnet in suspension, by the repulsion of like poles balancing its weight. In common with others, I have always failed to do this with steels hitherto available. The experiment fails through inability of the small magnet to resist having its poles reversed, or diminished in strength, by the intense field necessary for levitation.

Recent research on magnetic steels has, however, produced steels having the necessary resistance against reversal of polarity and with the necessary strength of magnetic field.

I find that the experiment of flotation can be shown by using very simple apparatus. The best results have been obtained by using a solid rod of special steel, 2½ inches by $\frac{3}{16}$, weighing about twelve grams. This rod is enclosed in a flat glass cell, slightly larger, giving clearance of about 1 mm. between the ends and sides, so that the rod may be able to move freely. This glass cell should be open at the top, and have a vertical height of about 3 inches. The bottom should also be made of thin glass—old photographic plates (quarter plates) answer very well for making this glass enclosure, adhesive tape being used for joining the glass plates, which may be separated by flat pieces of wood or glass slightly thicker than the steel bar, to give sufficient clearance. The magnetised rod should rest freely on the glass bottom (Fig. 1).

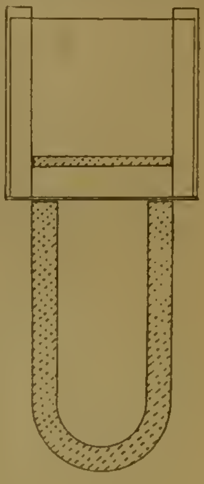

FIG. 1.

Holding the cell vertically, it is lowered slowly towards the poles of a horse-shoe magnet, held vertically. If the poles of the horse-shoe magnet are of the same sign as the opposing poles of the magnetic rod, the latter will rise and oscillate up and down in its enclosure. When properly adjusted in the field of a good magnet the rod will remain permanently poised about half an inch above the poles, which should be about the same distance apart as the poles of the levitated magnet.

Good bar magnets may be used, thus enabling the correct separation of the poles to be found experimentally.

A much greater distance of separation may be obtained by using an electro-magnet. In this case the cell must not be placed on the poles before turning on the current or the rod magnet will be reversed before it has time to rise and it will remain on the floor of the cell, being attracted. The same may happen if the cell is lowered awkwardly so that only one pole of the rod can rise: some reversal then takes place, necessitating remagnetisation of the bar. The particular steel used by me I owe to the kindness of Mr. W. H. Glaser, who tells me it contains 15 per cent cobalt and is known as "cobalt chrom" steel.

F. HARRISON GLEW.

156 Clapham Road, London.

Science and Economics.

F. S. M., the writer of the article "Labour and Science in Industry," in his rejoinder to my letter (NATURE, April 14, p. 498) does not seem to grasp my main point, that the present economic system has no sound *physical* foundation, and that it was an element of physical reality—for example, the laws of the creation of wealth as distinct from debt—that I wished introduced into the proceedings of the Economics section of the British Association. If the section has been proceeding on this road for a good many years now, as claimed, I apologise. But I am surprised at the slow progress it has made.

My "we," in the phrase "economic system under which we perish," was meant to be fairly catholic, and I have no objection to including the Russians and Chinese, though I think they may outlast us. My information about Russia is largely from schoolboys, who write to be told the latest about the atom; and about China, that the children work in mills twelve and fourteen hours a day, much as we worked ours here at the same stage of the industrial system. But on the question whether *we*, the British, are perishing or not, the statistics obtained during the medical examinations for compulsory military service were, to say the least, disquieting.

In reply to your correspondent, Mr. W. W. Leisenring (April 28, p. 571), the object of the examination I advocated is to find out what the physical basis of economics is, because I think it is entirely the opposite of what the economists seem to believe. There is no question of altering it. The natural laws in connexion with energy and matter were not known or understood when the present system was formulated. The system is a reflection of certain passing conditions, —an *ad hoc* system, good enough perhaps fifty years back, but perilous to-day. It should now be possible to found broadly the physical basis, embodying modern knowledge of the laws of energy and matter and the two undeniable principles of the Physiocrats and Karl Marx to which I made allusion. That human nature is admittedly imperfect is no reason why physical nature should be distorted to suit it, even if that were possible. Because drivers are imperfect and of uncertain individuality we do not insist on imitating their idiosyncrasies in the cars they drive. Rather we try to make them "fool-proof."

Mr. Leisenring deduces from my letter that "the natural obvious truths of the nineteenth century as interpreted economically are, in this century, both unscientific and senseless." I accept the deduction, much as I would if the words "spring" and "autumn" were substituted for the contrasted centuries; but I am not clear why Mr. Leisenring should disagree with my statement that no one pretends to understand the present system. His eulogy of it, whether historically justifiable or not, was couched in the past tense, whereas my criticism of it was couched in the present tense. With regard to the present financial system, however, if there is one defect it does not suffer from, it surely is age. Such a system as the present has never even been attempted before. It is an absolute innovation; and to suggest that it has evolved through several centuries *pari passu* with science, and that its ultimate basis is character and ability, merely shows that it is not understood. Its ultimate basis is credulity, and, by the standards of the Codes of Laws and social formulæ of all great civilisations, it is counterfeit.

FREDERICK SODDY.

MR. W. WILSON LEISENRING'S interesting criticism of Prof. Soddy's economic views in his letter printed in NATURE of April 28, p. 571, appears to have overlooked some of the most important causes of the present confusion in the world of economics. Among these I would put first the well-known psychological process of *inversion*, whereby the *means* is mistaken for the *end*, as exemplified by the old mercantile system or fallacy of representing the accumulation of gold and silver as the ultimate goal of commerce, and as being the true basis of national prosperity. Thus "protection," "tariff reform" (and, indeed, most of the "labour" or trades union ideals) are no more than survivals of a belief that *money*, instead of being the mere instrument of exchange and a measure of market values, is of itself the end and purpose of all trade and labour activity.

A fruitful source of confusion is also ambiguous terminology. Attempts are often made to divorce the economic concept of *wealth* from private property. In their strictly economical signification "wealth" and "labour" are unmeaning apart from property and market values. The same ambiguity applies to "capital," hence all the absurdities associated with the phrase "capital levy."

I venture also to differ from Mr. Leisenring's statement that "the ultimate basis of credit in any age is character and ability." We have here another illustration of inversion. The true basis of credit is surely *reputation*, *authority*, and *familiarity*. These again depend upon systematic advertisement, or, to put it less invidiously, upon "practical instruction."

ST. GEORGE LANE FOX PITT.

Travellers' Club, Pall Mall, S.W.1,
April 30.

Spermatogenesis of the Lepidoptera.

IN a letter to NATURE of April 28, p. 568, Prof. J. Brontë Gatenby states his position as to the criticism, made independently by Dr. R. Bowen of Columbia University and myself, of his account of the formation of the macromitosome in the spermatogenesis of Lepidoptera. In doing so he makes a statement that, if I understand it correctly, is inaccurate and is certainly misleading.

The macromitosome is formed by the coalescence of the mitochondrial vesicles. On this point we are all agreed. The mitochondrial vesicles consist of an inner chromophobic or lightly staining material surrounded by an outer layer of chromophilic or deeply staining material. Now, Dr. Bowen and I consider that the coalescence of the mitochondrial vesicles results in "merely larger aggregates of chromophobic material, the chromophilic material running together to form more or less complete partitions between the chromophobic droplets" (Bowen, *Q.J.M.S.*, 66, p. 601). On the other hand, Prof. Gatenby considers that the coalescence consists of the flowing together of the vesicles forming first of all elongated structures and then loops of chromophilic substance which ultimately join up to form a "perfectly coiled spireme" in a mass of the chromophobic substance.

In his letter Prof. Gatenby uses the expression "whether the 'spireme' was formed of a flat ribbon, or a round string." This, presumably, indicates his conception of the difference between our views. If it does not, I have failed to grasp the necessity of this phrase. So far as I am aware, Dr. Bowen has never suggested that the mitosome is formed by the twisting of a ribbon, and I, certainly, have never used the word "ribbon" in this connexion. A mass of soap bubbles cannot be described as made up of a twisted ribbon of soap solution, whereas it can be described as a plate work, and that is the description continually given by Dr. Bowen.

I do not think that the difference between Prof. Gatenby's view and that of Dr. Bowen and myself is of as little consequence as Prof. Gatenby implies in the third paragraph of his letter. If his views as to the formation of the Lepidopteran mitosome are adopted, then the Lepidoptera are unique among all the insects in which spermatogenesis has been described. This is a view that one would hesitate to adopt, especially in view of the fact that practically all other recent workers on the spermatogeneses of all other insects agree more or less closely with the account of the plate-work mitosome of Dr. Bowen. For this reason it became important to confirm, if possible, Prof. Gatenby's description. Dr. Bowen carried out his work on the Lepidoptera especially for this purpose, and came to the conclusion that Prof. Gatenby's interpretation of the process was inaccurate. If, then, Dr. Bowen's account is accepted, the Lepidoptera are brought into line with other insects, and this is certainly an important result. In view of this it seems very unfortunate that Prof. Gatenby has stated that, apart from Dr. Bowen's new interpretation of the sperm tail, "he adds nothing new to our knowledge of the spermatogenesis of the Lepidoptera." He considers the value of Dr. Bowen's work to lie in the fact that it confirms his own drawings of the appearance of the mitosome. After carefully comparing Dr. Bowen's paper with the original paper by Prof. Gatenby (*Q.J.M.S.*, 62, p. 407) I really cannot agree that there is any confirmation whatever. One figure by Dr. Bowen (Fig. 43) superficially resembles a corresponding one in Prof. Gatenby's paper (Fig. 14). Otherwise the figures of the mitosome are totally different in the two papers.

Prof. Gatenby has not answered the criticism that I have made of his original description of the formation of the mitosome. I cannot see how the chromophilic outer surface of a drop—which, of course, has an appreciable area—can, by fusion with another drop, or even by mere elongation, become transformed into a thread-like loop that has no appreciable area. He states merely that the mitochondrial vesicles flow together, "forming, at first, elongated structures, then loops, and finally filaments." I have pointed out (*Q.J.M.S.*, 66, p. 665) that I consider the figures that accompany this description inaccurate and misleading. Further, if such a process does take place, surely it would be possible to observe the intermediate stages, and would not these, in any case, be some sort of plate work? If Prof. Gatenby would enlarge upon his somewhat brief description it might help to clear up the differences between our views.

With regard to the opinion of the late Prof. Doncaster on the formation of the mitosome I should like to add a few remarks. In 1919 I had the privilege of assisting Prof. Doncaster in working out the spermatogenesis of the louse *Pediculus corporis*. We divided the work into two, he dealing chiefly with the chromosome aspect, while I dealt mainly with the cytoplasmic inclusions. At first Prof. Doncaster was inclined to believe that the mitosome was formed in the manner described by Prof. Gatenby, and, in fact, in the original notes, which I now possess, there are rough drawings by Prof. Doncaster figuring the mitosome as a spireme. I could not accept this view, and explained my conception to him. Ultimately he agreed with me, and it was at this time—about May or June—that he paid the visit to Prof. Gatenby, and objected to the latter's description of the mitosome of Smerinthus. However, that he was quite prepared to accept Prof. Gatenby's description is shown by the fact that in his last book on cytology he gives Prof. Gatenby's account in full and does not, I think, refer to our own observations on Pediculus.

H. Graham Cannon.

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The Rodier System of Rat Repression.

In connexion with the article on "The Rat and its Repression," contributed by me to Nature of May 20, 1922 (vol. 109, p. 659), I have been favoured with a letter from Mr. Wm. Rodier of Melbourne, in which he complains that my attitude to his system of rat repression is unsympathetic, or that, conversely, he is misunderstood.

I should esteem it a favour if you would allow me to say that I am not unsympathetic to any means of destroying the rat—an animal which I, at least, consider to be one of the greatest menaces of modern civilisation.

The attitude I take to the "Rodier Method" of rat destruction is that its principles are so thoroughly understood by all who have studied the rat problem that I am conscious of no unfairness when I suggest Mr. Rodier harms his cause when he asserts that those who do not immediately and unreservedly become his disciples are necessarily antagonistic, or stupid.

The difficulties Mr. Rodier has to overcome are such as are presented by the attitude of authorities towards putting rats back by rat-catchers who are paid to destroy their catches; the attitude of business houses when they pay for rat-clearing and find male rats turned back; and the plight of boroughs who make it their business to destroy female rats, when they find their polygamous males mated by females from contiguous boroughs where the "Rodier Method" is not in operation.

The whole question is one of education, and my immediate object is to convince the public that the rat is one of man's most dangerous foes, and one that is too expensive to maintain. As for the Rodier method, I have an open and sympathetic mind; and I would suggest that it would help Mr. Rodier's propaganda enormously if he could show us good results that could be scientifically checked, say in an island like Tristan da Cunha, or the Isle of Man. The authorities in the former island, where I am assured rats climb trees, would doubtless welcome assistance to overcome their terrible foes.

Alfred E. Moore.

The Incorporated Vermin Repression Society,
44 Bedford Row, London, W.C.1,
April 28.

Active Hydrogen by Electrolysis.

In 1907 Fischer and Massenez (*Z. anorg. Chem.*, 52, 202, 1907) obtained a concentration of 17 per cent. by weight of ozone when they electrolysed a solution of sulphuric acid, using a very high current density. Since ozone can be produced by this method, it would seem probable that a high current density at the cathode might aid in producing the ozone form of hydrogen. When a solution of sulphuric acid is electrolysed, using the above principle, the hydrogen that escapes at the cathode contains an active constituent which combines with pure nitrogen to form ammonia. Some of the ammonia formed is collected in the absorption bulb, but quite a large portion of it remains dissolved in the sulphuric acid solution. This active constituent in the hydrogen that is evolved at the cathode is probably the ozone form, and is produced perhaps in a manner analogous to the ozone form of oxygen. The per cent. of the active gas formed varies with the current density and the concentration of the acid.

Likewise, if a solution of potassium hydroxide is electrolysed, using a high cathode current density, the escaping hydrogen contains the ozone form which combines with pure nitrogen to form ammonia.

In the electrolysis of the acid solution the escaping hydrogen contains a fog which persists after passing through the absorbing solution. This fog is similar to, but less dense than, the fog sometimes produced by ozone when it is bubbled through potassium iodide solution.

This work is a further verification of the theory of Dr. G. L. Wendt that tri-atomic hydrogen may be produced wherever atomic hydrogen is formed.

A. C. Grubb.

Dept. of Chemistry,
University of Saskatchewan,
Saskatoon, Sask., Canada,
April 18.

The Low-power Aeroplane or Aviette.

By Prof. L. Bairstow, F.R.S.

MUCH attention is being paid in the general and technical press of this and other countries to flight with low-powered engines. The addition of small engines follows quickly on the gliding successes of the past year, but no marked connexion is discernible between the new features of the two types of flying machine. The change from aeroplanes having two or three hundred horse-power, and carrying a single individual, to aeroplanes of five to ten horse-power is now so striking as to have stirred public imagination. Many of those now interested are probably unaware of the flights made by A. V. Roe more than ten years ago with a nine horse-power J.A.P. engine.

There is little in the new applications which would warrant the use of the word discovery, and the change is probably due in large measure to an emancipation from the fetters of war ideas. There is reason to suppose that aeroplanes designed for official use are subject to so many restrictions that development is difficult. The advent of the low-power aeroplane is therefore welcomed as a new outlet for ideas, one which gives scope to individual initiative, and one which it is hoped will make a popular appeal.

The unofficial character of the British development of the aviette is emphasised by the offering of a prize of 500*l*. by the Duke of Sutherland for a light aeroplane of British manufacture and design; for the Duke is Under Secretary of State for Air, though he is not acting in his official capacity. A separate prize of 1000*l*., open to the world, is offered by the *Daily Mail*. The most striking conditions of the competition are: "The power unit must not exceed 750 cc. total cylinder capacity, and the prize will be awarded to the machine which flies the longest distance on one gallon of petrol, with a minimum distance of fifty miles to qualify."

Many other conditions apply which relate to ease of handling on the ground; there is also the usual vague reference to stability. It is in accordance with our present state of knowledge and application that, while the requirements for performance are always precise and well-defined, those for stability and control are valueless. In the competition rules for the low-power aeroplane there is neither definition nor means of checking aircraft as delivered in order to ensure a due measure of stability and control.

The French are, as is usual in matters relating to aviation, taking an active interest in the aviette, and in the *Times* of April 6 we find an article based on a flight by M. Barbot from Francazal to Toulouse in a seven horse-power aviette. The ideas of the flyer appear in the following quotation:

"M. Barbot, who is in Paris, expresses the belief that his aviette is the forerunner of the aero-taxi of the immediate future. He contemplates the production of a machine which will cost about five thousand francs (nominally 200*l*.), which can rise from almost anywhere and, furnished with a ten or fifteen horse-power motor, can land slowly within thirty yards of its objective and without any risk. . . . The cost will be only that of a gallon of petrol per hundred miles."

In the same issue of the *Times* is a reference to a British "power-driven glider":

"The test began yesterday at Ashton Park, Preston, of the first British auxiliary-engined glider, the Wren, designed and built by the English Electric Company at their Preston works. It is expected that the machine will provide valuable data on which to base the development of the economical aeroplane of the future. It has been constructed for the Air Ministry. It is remarkably light, being about 3 cwt., and the dimensions are: span 37 ft., length 23 ft., height 5 ft. The engine is a three horse-power A.B.C. motor-cycle engine, developed to seven horse-power, and gives a maximum speed to the aviette of forty-eight miles an hour. . . ."

These two extracts exhibit the features which define the low-power aeroplane, and in the remainder of this article it is proposed to analyse the projects and achievements in relation to the scientific knowledge involved. It will be found that the expectation of 100 miles per gallon of petrol in an aero-taxi carrying pilot and passenger is optimistic but not wildly in excess of what can be immediately foreseen, using arguments based on well-established data. On the other hand, risk is only incidentally reduced, and neither the extracts nor current technical literature show any attempt on the part of the designers of light aeroplanes to pay special attention to the fundamental problems of stability and control.

For the past eight or ten years it has been realised that all good aeroplane design tends to produce a result in which, for the most economical speed of flight, the weight carried is about nine times the resistance experienced. All high-power aeroplanes are able to exceed this most economical speed very greatly, with the result that at their maximum speed near the ground the resistance is more than one-quarter of the weight. If there be no great reserve of power, considerable height above the ground is unattainable, and the most economical speed is fixed by the design of the aeroplane, in particular by the magnitude of the load carried per unit area of wing surface. A common loading has been 7-8 lb. per sq. ft. corresponding with an economical speed of about 60 miles per hour; a reduction of loading to 2 lb. per sq. ft. would bring the best speed to about 30 m.p.h.

If the making of a specified journey be the basis of comparison, then speed in itself has no influence on petrol consumption per unit of weight carried, but the horse-power required is directly proportional to the speed. Indirectly, low speed is advantageous, since a smaller and light engine suffices for transport. Taking figures given in the Press as a basis, it appears that the aviette with a single occupant would weigh about 550 lb. all told, whereas the single-seater fighting craft weighs from three to four times this amount. The maximum speed claimed for the aviette is only about one-third of that achieved by the scout.

Further data lead to an estimation of a probable mileage per gallon of petrol. Many aero-engines exist in which the petrol consumption does not exceed 0·5 lb.

of petrol per brake horse-power per hour, and it is probable that an airscrew efficiency of 75 per cent. may be reached. With petrol weighing about 7 lb. to the gallon it will be found from those figures and a weight-resistance ratio of 9 that the number of miles possible per gallon of petrol consumed is roughly equal to thirty thousand divided by the weight of the aeroplane. To achieve 100 miles to the gallon, therefore, it would be necessary to improve on existing figures for performance, since a gross weight of 500 lb. yields only 60 miles per gallon. As an aero-taxi with pilot and passenger would weigh more than 500 lb. it would appear that M. Barbot's estimate is not to be easily achieved.

It will be noted, however, that the condition of a minimum of 50 miles per gallon in the competition rules for the Duke of Sutherland prize is reasonable. It will exclude seriously inefficient design without setting an impossible task.

In making the preceding calculations, no allowance was made for the use of energy obtained from the wind itself. As we all know, aeroplanes without engines, *i.e.* gliders, have maintained themselves in the air for several hours consecutively, utilising winds deflected upwards by a sloping hill-side. Up-currents of sufficient intensity for support are very local, and we are yet far from being able to use them for point-to-point journeys as distinct from tacking backwards and forwards in a chosen locality. The phenomenon of gliding, as we know it, does not modify the estimate of power already made, but does show how part of that power may be obtained from the wind. Langley contemplated the extraction of energy from the pulsations of the wind, quite apart from their direction, and this source of energy is probably very widely distributed. So far, however, little, if anything, has been attempted in practice in the extraction of this energy, and there is no clear lead as to the direction in which one might hopefully proceed.

For some time to come, it may be expected that the aviette will carry the main source of power for its support; economy of fuel may be obtained by utilising up-currents in the neighbourhood of flight and so using the engine in passing from hill crest to hill crest. The condition attached to the Duke of Sutherland prize that the competition is to take place over a triangular course of not less than 15 miles reduces the chances of obtaining substantial amounts of energy from the atmosphere.

Since a claim for reduction of risk has been made, it may be as well to state the view that the only contribution made to safety is in the sense that it is less dangerous to strike the ground at 30 m.p.h. than at 60 m.p.h. The inherent defects of the modern aeroplane which make for danger on stalling are quite untouched by the new application.

The low-power aeroplane can scarcely fail to react beneficially on scientific knowledge and its applications. At the moment, however, it would appear that the aviette has derived its being from knowledge obtained for other purposes and has not reached the stage of reciprocation.

[Since this article was written, a very definite advance in the practical use of the low-power aeroplane has been made by M. Barbot, who, as was recorded in our issue of May 12, p. 645, succeeded in completing the round trip from the French coast to Lympne in Kent and back again, covering about 80 miles, in a machine with a 15 h.p. engine. His time for the journey was about two hours and a quarter, including nearly half an hour's stay at Lympne, and it is stated that his petrol consumption was about two gallons.]

The Earth's Electric and Magnetic Fields.[1]

By Prof. W. F. G. Swann, University of Minnesota.

II.

Two of the most characteristic features of the earth's magnetism are the non-coincidence of the magnetic and geographic axis, and the secular variation. While a theory which is to claim any degree of completeness must account for these, one cannot resist the temptation of searching for any sort of phenomenon capable of giving a field of the order of magnitude of the earth's field in the hope that if such be found it may serve as a possible basis on which to build a more complete theory.

Attempts towards a theory of the earth's magnetism may be classed roughly in the following four groups:

(1) The earth is assumed to be made largely of iron, and to be a permanent magnet independently of its rotation, or to be magnetised inductively by an external field.

(2) The magnetic field is brought about by the rotation of an electrostatically charged system.

(3) The magnetic field arises from a state of magnetisation brought about by the rotation of the earth.

(4) The field is caused by electric currents circulating within the earth.

The high temperature of the earth's interior would be inconsistent with a state of permanent magnetisation unless the effect of high temperature is compensated in some way by that of high pressure. Induced magnetisation suffers from the same cause, and would, moreover, give a type of field totally unlike the earth's field.

As regards (2), a sphere of the earth's size, rotating with the earth's angular velocity, would have to possess such a surface charge as would give it a potential gradient a hundred million times the earth's potential gradient in order that the rotation of that surface charge would produce a magnetic field comparable with the earth's magnetic field. Even then, it turns out, as has been shown by Schuster and by the writer, that owing to the effect of the observer's motion with the earth's surface, a sign of charge which gave the right direction for the vertical component would give the wrong direction for the observed horizontal component.[2]

[1] Continued from p. 642.

[2] Inclusion of the effect due to the atmospheric positive charge annuls completely the magnetic field which would be observed by one moving with the earth.

The difficulties arising from the large electric field, and from the inconsistency in sign between the horizontal and vertical components may be avoided, at first sight, by supposing, with Sutherland, that the earth may be regarded as two superposed spheres of positive and negative electricity, the diameter of the negative sphere being greater than that of the positive. The electric field at external points would be zero, but the magnetic field would not be zero. The actual density of positive and negative electricity in the earth is so great that, if all the positive and negative electricity in a cubic centimetre could be concentrated at two points one centimetre apart, they would attract each other with a force of the order 10^{20} tons; and, on account of this, it is only necessary for the radii of the two spheres of the size of the earth to differ by 2×10^{-8} cm. (the diameter of a single molecule), in order to ensure that the two, rotating together, would give rise to a field of the order of magnitude of the earth's field. Unfortunately, however, we find that the electrostatic forces opposing even this small separation are enormous, amounting to more than one thousand million volts per centimetre at the surface of the inner sphere.

Regarding forces which suggest themselves as possibly available for causing electrostatic separations of the above or allied kinds, we have, in the first place, gravity, tending to pull the free electrons towards the earth's centre, then centrifugal force tending to make them fly to the surface. Another possibility arises from an action analogous to the Thomson effect, by which the electronic density tends to decrease as we descend towards the earth's centre, on account of the increase of temperature. These effects have been submitted to calculation by the writer, and it appears that the first gives rise to a field only 10^{-21} of the earth's field, and in the wrong direction, the second to a field about 10^{-23} of the earth's field, but of a type widely different from that of the earth, and the third to a field in the right direction but amounting to only 10^{-17} of the earth's field.

As a general rule, we may say that it is practically hopeless to seek an explanation of the earth's magnetic field on the basis of the rotation of charges which have been separated against electrostatic attraction, since the mechanical forces necessary to produce the requisite separation must be, in all cases, enormous.

If the earth were made mainly of iron, its rotation would, by gyroscopic action, bring about a partial orientation of the molecular magnets; and it has been experimentally demonstrated by S. J. Barnett that iron can be magnetised in this way. The effect in the case of the earth is, however, extremely small, and is only sufficient to account for a magnetic field 2×10^{-10} times that of the earth.

The suggestion has been made that the interior of the earth may be endowed with enormously high permeability, and that, in consequence, a very weak force would be sufficient to cause strong magnetisation therein. We must remember, however, that the very creation of a state of magnetisation within a sphere brings about an internal demagnetising field which is, as a matter of fact, equal to the external field at the equator. Hence any primary magnetising agent which is to be ultimately responsible for the earth's field must be of such intensity that it will produce, on the molecular magnets, forces at least equal to the forces which would be produced on them by a magnetic field equal in intensity to the earth's magnetic field at the equator.

Any theory attempting to account for the earth's magnetic field on the basis of currents circulating within the earth, calls for some explanation of the electromotive force wherewith to produce the currents. In this connexion it is of interest to recall a calculation by H. Lamb, to the effect that if currents were caused to circulate in a copper sphere of the earth's size, and the electromotive forces which caused them were removed, the currents would take ten million years to decay to one-third of their initial values. Attempts to account for the earth's field in this way have met criticism on the basis of the enormous currents which would be calculated by extrapolation back, even to epochs not more remote than those during which the earth's crust has been solid, so that, unless there is some reason for supposing that the conductivity is, or has been, in the past, even greater than copper, we are confronted with accounting for the enormous amounts of energy necessary to have produced the field initially.

The actual current density within the earth necessary to account for the earth's field is very small, being, for example, of the order 10^{-8} ampere per square centimetre on the surface at the equator for the case where the current density is proportional to the distance from the axis of rotation. If, taking a sphere of iron, we assume about 10^{23} free electrons per c.c., it is only necessary to suppose that the mean velocity of the electrons at the earth's surface, relative to the centre, differs from that of the periphery by one part in 7×10^{16} in order to account for this current. It is, perhaps, not too much to hope that a fuller knowledge of the mechanism of conduction in solids than we have at present may lead to an explanation of such a small difference as arising directly on account of the earth's rotation.

There is always the chance that the origin of the earth's field may have to be sought in some fundamental but small departure from the ordinary electrodynamic laws. In this connexion we may recall Lorentz's theory of gravitation, according to which gravitational forces may be accounted for by supposing that the attraction between two unlike units of charge is different from the repulsion between two like units. Paying due regard to the care necessary in defining electrical neutrality in this case, the theory may be shown to lead to the conclusion that, in order that the free electrons in a body shall be in equilibrium, the body must acquire a charge density to an extent not wholly determined by the weight of the electrons. Schuster has discussed the possibilities in this regard, but it would appear that, under the most favourable assumptions, the density would be insignificant as regards producing, by its rotation, a magnetic field comparable with the earth's field.

A greater measure of success is attained by making a somewhat similar assumption concerning the magnetic field produced by a moving charge. We first observe that a magnetic field is ultimately measured in terms of the force which it exerts on a moving electron; for even a material magnet which may be used in the measurement derives its properties from electrons rotating within it. In analogy with the case of electrostatics, where we have to deal with the forces produced by positive on positive, negative on negative, and positive on negative, we have, in addition, for moving electrons, the force due to the motion of a positive electron on a moving positive electron, the force due to the motion of a moving negative electron on a moving negative electron, the force due to the motion of a negative electron on a moving positive electron, and the force due to the motion of a positive electron on a moving negative electron. The first two of these four may be taken as the basis for defining the measures of the two types of magnetic fields produced by positive and negative electrons respectively. If, for similar motions, these four forces are all equal, a moving electron, or a magnet, would be entirely unaffected by the rotation of the earth as a whole.

If, however, the forces, due to motion, between unlike moving charges are suitably different from those between like charges in the same states of motion, it will immediately appear that the electrically neutral earth will, by its rotation, produce those forces on magnets and moving electrons which we associate with a magnet as ordinarily defined. By making the forces between electrons of like sign equal for both signs, the force due to the motion of a negative electron on a moving positive electron greater than, and the force due to the motion of a positive electron on a moving negative electron less than the forces between like electrons to the extent of about two parts in 10^{19}, we can account for the equivalent of a magnetic field of the order of magnitude of the earth's magnetic field. If we wish to combine these alterations with suitable alterations in the electrostatic forces, we can also include gravitation in the complete scheme.

The secular variation presents interesting problems for speculation. There is some evidence for the belief that the earth's magnetic axis rotates about the geographic axis once in about 500 years. This will result in induced currents, and the field we observe will be that due to these induced currents (the secondary field), and that due to the primary causes (the primary field). Taking an iron sphere of the earth's size for purposes of illustration, it works out that the flux of the secondary field through the sphere, which is, of course, related to that of the primary field, is of such magnitude as to annul almost completely the non-axial component of the primary flux, leaving only a small residual non-axial component, which lies, moreover, perpendicular to the primary non-axial component. Thus, in order that the resultant flux shall have an appreciable inclination to the geographic axis, it is necessary for the primary axis to lie very near to the equatorial plane, and yet for the primary flux to be so large that its axial component, which is small compared with it, represents the axial component which we observe. This example is given merely to illustrate the important rôle which might be played by the induced currents due to the secular variation in case the earth's interior had a conductivity comparable with that of iron.

The theory of the diurnal variation is in a better position than that of the earth's field as a whole. The suggestion of Balfour Stewart, developed in detail by Schuster, to the effect that the diurnal variations are caused by Foucault currents generated in the upper atmosphere by the tidal motion of the atmosphere across the earth's lines of force, seems well adapted to fit the facts, its chief difficulty being that it calls for a conductivity about 3×10^{11} times that found at the earth's surface. Various agencies have been invoked to account for this conductivity, namely, ultraviolet light, gamma rays, negative electrons, and alpha rays, from the sun, and finally charged atoms of gas, shot out from the sun by the pressure of light, and endowed thereby with velocities sufficient to give them the properties of low energy alpha particles. The corpuscular radiations have also been invoked to account for the phenomena associated with the aurora.

It is probable that ultraviolet light plays no important rôle, since it is capable of accounting for a conductivity less than one-millionth of the conductivity required. As regards the corpuscular radiations, the nature of the precipitation of corpuscles indicated by the aurora is of a type to correspond to a bending by the earth's magnetic field such as one would not readily associate with particles of mass as small as that of electrons. The mass of an electron increases with its velocity; but, so greatly has Birkeland found it necessary to draw upon this phenomenon in order to fit the facts, that, on the hypothesis of negative electrons, he is driven to assume velocities ranging from 400 metres per second less than the velocity of light to 4 metres per second less than that limit. Alpha particles have a mass and energy which would be better adapted to account for the aurora, as has been pointed out by Vegard; moreover, the definiteness of their range ensures the characteristic feature of the sharp boundary of the luminescence, and the magnitude of the range is fully sufficient to account for the penetration of that boundary to the altitudes observed.

The remarkable perturbations of the earth's magnetic field known as magnetic storms, which occur most frequently in association with high solar activity, suggest the entry into our atmosphere of electrified corpuscles during these periods, and it is natural to look to those corpuscles which are responsible for the conductivity and the aurora for an explanation of these storms. While alpha rays have been suggested, some of the difficulties inherent in the assumption may be gathered from considerations put forward by Lindemann. On the assumption of their production by alpha rays, these storms would call for an incredibly large amount of radioactive material in the sun. Again, a conical beam of alpha rays, such as appears to be necessary to account for the storms, would, on its journey here, suffer, by self-repulsion, an acceleration of about 10^{13} cm./sec.^{2} at its boundary, in such a sense as to make it spread, so that it could never arrive as a beam. Finally, even if the beam could reach our atmosphere, it would charge it at such a rate that the repulsion due to the charge which had arrived would, in a few seconds, attain a value sufficient to prevent the entry of any more rays.

It is for reasons such as these that Lindemann has been led to favour the view that the primary agencies responsible for magnetic storms are atoms of gas, ionised by the high temperatures in the solar prominences, and shot out of them by the pressure of the sun's radiation. He shows, moreover, that the velocities to be expected in these circumstances are such as to give the particles ranges in harmony with the requirements of auroral phenomena.

The Tercentenary of Sir William Petty.

OF the founders of the Royal Society, Wilkins was born in 1614, Goddard and Seth Ward in 1617, Evelyn and Bathurst in 1620, Willis in 1621, and Petty in 1623. Boyle and Wren were somewhat younger, being born in 1627 and 1632 respectively. Petty, whose tercentenary occurs on May 26, was thus thirty-seven years of age when the Society was inaugurated, and had already given evidence of great administrative powers. Unlike most of his fellow scientific workers, his education was gained mainly on the Continent, and he was a man of twenty-four or twenty-five when first he settled at Oxford. He was born at Romsey in Hampshire, the son of Anthony Petty, a clothier, and as a boy attended the Romsey Grammar School. From there at the age of fifteen, with a consignment of his father's goods, he crossed to France, where he entered the Jesuit College at Caen, apparently maintaining himself by the sale of his father's merchandise.

From Caen, Petty returned home, served for a short time in the navy, but at the outbreak of the Civil War went abroad again, spent some time at Utrecht and Amsterdam, and in 1644 matriculated as a student of medicine at Leyden. He is next found in Paris, becoming known to Hobbes, Sir Charles Cavendish, and other English refugees, and attending the meetings of Mersenne, from which ultimately sprang the Paris Academy of Sciences. Once more at home he took up his father's business, invented a process for duplicating letters, and in 1648 published his tract on education, "Advice to Mr. Samuel Hartlib, for the Advancement of Some Particular Parts of Learning." He proposed the establishment of a College of Tradesmen, with botanical theatre, observatory, etc., the members of which "would be as careful to advance arts, as the Jesuits are to propagate their religion."

Petty next removed to Oxford, where he was able to associate with the philosophers who during those troublous times kept the lamp of science burning. Many of the meetings which Wilkins and Boyle frequented were held at Petty's lodgings. In 1649 he took his doctor's degree in physic, and a year or two later became professor of anatomy.

From Oxford Petty was now sent by the Commonwealth Government to Ireland as physician general to the forces, where he quickly added to his reputation by reorganising the medical services. The terrible massacres of 1641 had by this time been ruthlessly avenged by Cromwell, and all who could not prove "consistent good affection" to the English Government were to be dispossessed of their lands. This resulted in some 3000 native landowners losing their property. To Petty was given the task of measuring and surveying the forfeited estates. His survey, which has been described as the first attempt to carry out a survey on a large scale and in a scientific manner, is curiously known as the "Down Survey" because it was measured "down" on maps. Besides this, Petty also made a map of Ireland, completed about 1673, largely at his own expense. By his work in Ireland Petty himself gained considerable estates in Kerry and later on set up ironworks, opened lead mines and marble quarries and started a timber trade. His duties were not carried through without gaining for him many enemies, and in the last Parliament of the Commonwealth he was impeached and for a time his fortunes hung in the balance.

With the Restoration, Petty, who disliked extremists of all parties, was received favourably by Charles II. and was confirmed in the possession of his Irish estates. He now was able to resume the society of his scientific friends, and he was present at Gresham College on November 28, 1660, when the Royal Society was formed. He became a member of the first council and often contributed papers to the Proceedings of a practical nature. He is several times mentioned in connexion with the subject of shipping, and in 1662 made some stir by the mention of a double-bottomed or twin-hulled boat which would go against wind and tide. A ship constructed to his plans made two voyages between Dublin and Holyhead and was then wrecked. The idea has been put into practice several times since the days of Petty, notably so in the case of the channel steamer *Calais-Douvres* constructed in the 'eighties of last century. At one meeting of the Royal Society Petty "was intreated to inquire in Ireland for the petrification of wood, the barnacles, the variation of the compass, and the ebbing and flowing of a brook." Among his other services to the science of his day was the part he took in the foundation of the Dublin Philosophical Society in 1684, of which he was president. He drew up for the Society a "Catalogue of mean, vulgar, cheap and simple experiments," and among his advice to the members was "that they carefully compute their ability to defray the charge of ordinary experiments fforty times per annum, out of their weekly contributions, and to procure the assistance of Benefactors for what shall be extraordinary, and not pester the Society with useless or troublesome members for the lucre of their pecuniary contribution."

Petty was full of worldly wisdom and possessed what Benjamin Martin called a "universal practical genius." One result of this was that he died a very rich man. But at a time when such studies were rare he wrote on taxes, revenue, the origin of wealth, trade, population, and the growth of cities. It is on his work as a political economist that his reputation rests. He condemned the farming of the revenue of Ireland, suggested free commercial communication between that country and England, and consistently urged upon the Government the necessity of a department for the collection of statistics. He co-operated with John Graunt, another original member of the Royal Society, in the production of a book entitled "National and Political Observations . . . made upon the Bills of Mortality," published in 1662, which may be regarded as the first book on vital statistics ever published.

A tall handsome man, Petty was known among his fellows for his unusually good temper. Evelyn said of him "there was not in the whole world his equal for a superintendent of manufacture and improvement of trade, or to govern a plantation," and Pepys refers to the charm of his society. Knighted by Charles in 1661, Petty in 1667 married a daughter of Waller the regicide, and was survived by three children. He twice refused a peerage, but his widow was created Baroness Shelburne. He died in Westminster on December 16, 1687, and was buried in the Abbey Church at Romsey.

Obituary.

Prof. E. W. Morley.

In the issue of *Science* for April 13, appears an appreciative notice by Prof. O. F. Tower, professor of chemistry in Western Reserve University, of the life and work of Prof. E. W. Morley, whose death was announced in Nature for April 28, p. 578.

Edward Williams Morley was born in Newark, New Jersey, on January 29, 1838, and in 1869 went to Western Reserve College, then in the town of Hudson, as professor of natural history and chemistry. In 1882 the College was moved to Cleveland, becoming Adebert College of Western Reserve University, and there Prof. Morley taught general chemistry and quantitative analysis until his retirement in 1906 as emeritus professor.

Prof. Morley's first work of importance, undertaken while he was still in Hudson, was on the relative proportion of oxygen in the air (1878–81). The work for which he is best known to chemists, however, was on the densities of oxygen and hydrogen and the ratio in which they combine; this was carried out at Cleveland and published in 1895. It is a remarkable tribute to his work that now, after nearly thirty years, the accepted values of these quantities are practically identical with those found by him. Prof. Morley was also eminent as a physicist, and his characteristic for precision of measurement is shown in his early papers on rulings on glass and on the probable error of micrometric measurements. While at Cleveland, he collaborated with Prof. A. A. Michelson in the development of the interferometer, and with this instrument the well-known Michelson-Morley experiment on the relative motion of the earth and the ether was carried out. The experiments, though giving negative results, were resumed later in conjunction with Prof. D. C. Miller.

The accurate work on the determination of the relative atomic weights of hydrogen and oxygen won for Prof. Morley the Davy medal of the Royal Society in 1907; while in 1904 he had been elected an honorary fellow of the Chemical Society. He was also an honorary member of the Royal Institution. In the United States he received the honour of being made president of the American Association and of the American Chemical Society in 1895 and 1899 respectively. He died on February 24, about a month after his eighty-fifth birthday.

Sir Shirley Murphy.

Shirley Murphy's name during the last thirty years has been a household word in the ranks of public health workers; and his work as medical officer of health for the county of London during a period of twenty-two years was marked by great improvements in the administrative control and prevention of disease. From this post he retired a few years before the War, but at its onset his services were utilised in taking charge of the sanitary services of the London area, for which work he was created K.B.E. in 1919, having been previously knighted in 1904.

It is, however, rather in Sir Shirley Murphy's contributions to the science of epidemiology that Nature is chiefly interested. The factors making for or reducing the prevalence of such acute infectious diseases as scarlet fever, diphtheria, measles, and whooping-cough are complex; they differ from such diseases as typhus fever, typhoid fever, cholera, small-pox, and epidemic enteritis, which can be entirely controlled, given the adequate application of general and specific sanitation. Like the uncontrolled and only partially controllable diseases enumerated above, the members of this last-named group are subject to cyclical waves, seasonal and longer waves; but the vehicles of infection can be put out of action, or by vaccination in the case of smallpox, personal immunity is obtainable. Murphy made many contributions in his annual reports and in the Proceedings of the Epidemiological Society to the study of seasonal influences on scarlet fever and diphtheria, showing that there have been in London seasonal variations in both the fatality (*i.e.* case-mortality) and age distribution of notified cases of these diseases. The cases of these diseases at ages under five form a larger proportion of the total cases at the beginning and end of the year than in its middle; and even when the necessary corrections are made for variations in age and sex of the cases, the fatality from these diseases is subject to seasonal variations. Murphy advanced the view that the change in the age incidence of death-rates from phthisis is explicable by successive additions by birth of a more resistant race, a tenable hypothesis, though not supported by international facts as to the phthisis death-rate.

The presidential address delivered by Murphy to the Epidemiological Society on "The Study of Epidemiology" is perhaps the best illustration of his wide knowledge and keen interest in epidemiological problems. At the same time it shows very clearly the complexity of factors making this study a formidable struggle with difficulties. He did much to assist in laying the foundations of a more accurate science of epidemiology; and in the pursuit of this study his annual reports to the London County Council will always be a valuable mine of information.

Murphy's work was recognised by his own profession, for he was awarded the Jenner medal by the Royal Society of Medicine and the Bisset Hawkins medal for distinguished services to public health by the Royal College of Physicians. His personality was singularly attractive; modest and unassuming, he was always ready to help his colleagues, and generous in his appreciation of their work.

Mr. Joseph Wright.

The death of Joseph Wright of Belfast on April 7, at the age of eighty-nine, removes one of the fine old school of naturalists whose interests were bounded only by the earth itself. Though prolonged attention to specific details might have seemed to outsiders a sign of a mind cabined and confined, Wright's enthusiasm over the sheer beauty of the organisms that he studied was an inspiration to the wide circle of his friends.

Joseph Wright was born at Cork in 1834, and, his parents being members of the Society of Friends, he was educated at the Friends' School in Newtown, Co. Waterford. His wife came also from Cork City, and, when he settled in business in Belfast in 1868, he brought the healthy and tolerant atmosphere of his upbringing to his new surroundings in the north. For a very long period of years Wright's daylight hours had to be at the disposal of firms for which he worked, and only on occasional holidays could he make excursions into the country. He was a warm supporter of the Belfast Natural History and Philosophical Society and of the Belfast Naturalists' Field Club. During his years in Cork he had made a fine collection of Carboniferous fossils, which is now in the British Museum; in Belfast he devoted himself mainly to the study of foraminifera, fossil and living, and was especially successful in extracting forms preserved in hollow flints or in friable chalk from the Cretaceous beds of northern Ireland. He was able to recognise forms derived from these beds in detrital deposits of the district, and he remained convinced that the occurrence of Pleistocene foraminifera in the glacial deposits studied by him necessarily implied an incursion of the sea over northern Ireland.

Wright joined, as a recognised expert, dredging expeditions in the Irish Channel and off the western coast, the latter being organised by the Royal Irish Academy. His judgment became sought by naturalists throughout our islands and abroad, and many of his correspondents, while appreciating the fulness of his knowledge, must have remained ignorant of the life of hard work and devotion in the intervals of which his researches were carried on. Those who became personally acquainted with him in his home could not fail to recognise his truly lovable personality.

Wright was elected a fellow of the Geological Society of London in 1866, and in 1896 received the honour of the award of the proceeds of the Barlow-Jameson fund. He contributed numerous papers to scientific journals, and his unique collection of foraminifera, mounted by his own hand, is now among the treasures of the National Museum in Dublin.

An excellent account of Wright's life and work, to which we are indebted for some of the details given above, appeared in the *Belfast Telegraph* for April 7.

Mr. Sidney H. Wells.

Mr. Sidney H. Wells, who died at St. Leonards on March 28, was formerly Director-General of Technical, Industrial, and Commercial Education in Egypt. Born in 1865, he was educated for the engineering profession at Birkbeck and King's College, London, and in 1885 he won a Whitworth Scholarship. Four years later he founded the Institution of Junior Engineers, of which he was chairman for five sessions. In 1889 he became a master at Dulwich College on the science and engineering side. Two years later he removed to the University of Leeds as senior assistant in the engineering department, and in 1893 he returned to London at the age of twenty-eight to become the first principal of the Battersea Polytechnic.

In 1906 Mr. Wells was requested by Lord Cromer to visit Egypt and report on technical education, certain branches of which had been previously entirely neglected. As a result of this visit, Mr. Wells was offered in 1907 the newly created post of Director-General of Technical, Industrial, and Commercial Education, a position which he held until his retirement eighteen months ago owing to continued ill-health. His fifteen years' work in Egypt was that of a pioneer, and the agricultural, commercial, and industrial schools which are to-day flourishing in all the larger towns of that country and in many of the provinces owe their existence entirely to Mr. Wells's untiring energy and far-seeing wisdom.

For his War work as Director of Civilian Employment for the Egyptian Expeditionary Force in 1917–19 Mr. Wells was made C.B.E.; he was twice mentioned in despatches, and held the second-class orders of the Medjidieh and the Nile. He was vice-chairman of the Egyptian Commission of Commerce and Industry, 1916–18.

Mr. Wells was an Assoc. M.I.C.E. and an original member of the Faculty of Engineering of the University of London, of which he was afterwards secretary, and also secretary of the Board of Studies. He was formerly a member of council of the Headmasters' Association, a member of council and for four years honorary secretary of the Association of Technical Institutions, and a member of the Examinations Board of the City and Guilds Institute, of the Teachers' Registration Council, and of the Consultative Committee of the Board of Education. He was the author of various text-books.

General E. A. Lenfant.

By the death of General E. A. Lenfant at the age of fifty-eight, France has lost one of the most noteworthy explorers of her African empire. He began his work in Africa in 1898, when he studied the course of the Senegal, and later the floods of the Niger. In 1901–2 he twice traversed the middle and lower Niger, passing the rapids successfully and collecting much useful information on the regime of the river and the geography of its valley. In 1903 Lenfant was again sent to Africa to investigate the possibility of water transport from the coast to Lake Chad. On this occasion he explored the Logone, a tributary of the Shari; the Kabi, a tributary of the Benue; and Lake Tuburi, which lies between the two. Between 1906 and 1908 Lenfant's explorations were in the western part of the Ubanghi-Shari country, around the head waters of the Shari. He showed that the Bara-Shari is a branch of the Shari, and that the Pende, which is the same as the Logone, provides the best route from the Sanaga to the Shari, and so to Lake Chad. Lenfant was the author of several works on Africa, including "Le Niger" (1903), "La grande route du Tchad" (1905), and "La découverte des grandes sources du centre de l'Afrique" (1909).

We regret to announce the following deaths:

Prof. J. Cox, lately professor of physics in McGill University, Montreal, on May 13, aged seventy-two.

Dr. G. H. Hume, for many years lecturer on physiology in the University of Durham College of Medicine, Newcastle-upon-Tyne, on May 8, aged seventy-seven.

Prof. C. Niven, F.R.S., lately professor of natural philosophy in the University of Aberdeen, on May 11, at seventy-eight years of age.

Colonel G. F. Pearson, formerly Inspector-General of Forests in India, on April 25, aged ninety-six.

Lieut.-Colonel J. C. Robertson, according to the *Times*, director of hygiene and pathology at Army Headquarters, Simla, and in 1912 sanitary commissioner with the Government of India, on May 14.

Current Topics and Events.

THE director of the Royal Botanic Gardens, Kew, undoubtedly does a public service when he forces upon the attention of the House of Commons and the general public the undesirable results that may follow from the thoughtless lack of control of smoke production in neighbouring industrial suburbs. There can be no doubt that heavy deposits of soot such as are borne by the evergreens at Kew are clear indication of atmospheric contamination which will markedy lower the vitality of the plants in the Gardens and in some cases may actually prevent their successful cultivation. When smoke particles are so numerous gaseous contamination with sulphurous acid is to be feared, and the evidence is conclusive that these acid impurities directly injure green foliage at the same time that their accumulation in the upper layers of the soil may injure root growth. The experimental results obtained by Drs. Crowther and Ruston and their colleagues in the agricultural department of the University of Leeds have supplied convincing examples of the extreme consequences that may follow industrial pollution in an industrial area, and the Kew authorities are wise in directing public attention to the danger before it has reached more serious proportions. At present, probably the greatest damage arises at Kew from the deposits of dark-coloured tarry material upon the leaf surfaces cutting down the supply of light which reaches them and clogging the pores through which are carried on gas exchanges vital to their healthy existence. Apparently the atmospheric pollution at Kew can be traced in the main to the industrial area on the opposite side of the Thames, and it is to be hoped that, as a result of the action taken by the director of the Gardens and by the Coal Smoke Abatement Society, prompt steps will be taken to bring about a cessation of a nuisance which, it must be emphasised, has frequently been shown to be capable of prompt control.

ARRANGEMENTS have now been completed for the celebration of the centenary of Pasteur at Paris and Strasbourg. The programme is as follows:—At Paris on Thursday, May 24, there will be a reception by the President of the French Republic at the Elysée; on Friday, May 25, a visit will be paid to the Institut Pasteur and tomb, and in the afternoon there will be a ceremony at the Sorbonne under the presidency of the President of the Republic; on Saturday, May 26, there will be a visit to the Ecole Normale, followed by a reception at the Hôtel de Ville; on Sunday, May 27, a reception will be given by the Sociétés d'Amitiés Françaises à l'Etranger, and there will be a *soirée* at the Opera and at the Théâtre Français; on Monday, May 28, there will be a banquet at Versailles; and on Tuesday, May 29, l'Institut de France is giving a garden-party at Chantilly. Thursday, May 31, will be spent at Strasbourg; the Pasteur monument will be unveiled, and a banquet will be held at midday; in the afternoon a visit will be paid to the Palais du Rhin, and the Pasteur Museum and the Hygiene Exhibition will be opened. The celebrations will conclude with a reception at the Hôtel de Ville in Strasbourg.

THE question of the deterioration of stonework in buildings is a matter of general economic importance. In the cases of our historic buildings and ancient monuments, prevention of the serious decay and gradual demolition of tooled surfaces and main structures constitutes a special problem which has engaged the attention of many investigators for a considerable time without, however, finding any generally satisfactory solution. The investigation involved is very complex and needs to be approached from different angles with the help of wide scientific knowledge. Accordingly, it has been decided to set up under the Department of Scientific and Industrial Research a special committee of the Building Research Board to report on the best methods by which decay in building-stones, especially in ancient structures, may be prevented or arrested. The following committee has been appointed: Sir Aston Webb (*Chairman*), Mr. R. J. Allison, Prof. C. H. Desch, Mr. A. W. Heasman, Mr. J. A. Howe, Sir Herbert Jackson, Dr. Alexander Scott, and Mr. H. O. Weller. All communications should be addressed to the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1.

PRACTICAL broadcasting was discussed at an informal meeting of the Institution of Electrical Engineers on April 23. Mr. Shaughnessy, of the Post Office, in opening the discussion, pointed out that in America official reports are calling for a radical change in present arrangements so as to remedy the existing confusion. The problem for the British authorities is how best to serve the potential listeners in Great Britain, the number of whom he estimated at about two millions. The amateur experimenters are in a very small minority. The possible alternatives are (1) a super-station, (2) a number of broadcasting stations of medium power, and (3) any number of irresponsible stations. The method adopted has been to form eight areas, each served by a medium power-station, the wave-length of each station being as different as possible within the prescribed limits from that of neighbouring stations. They had been placed at the centres of thickly populated districts, for this is the justification for a popular entertainment. There is no easy way of detecting those who have circuits which interfere with the general distribution. The average listener wants to select his programme, but if he is too near a broadcasting station it is very difficult to tune it out. Those who are some distance away from a station have a much better chance of picking up the programmes given by several stations. The tendency at present is to send out sounds which can be readily heard on the cheapest type of crystal set. The general opinion was that it was advisable to encourage the use of the best apparatus.

THE Botanical Society of South Africa was founded in 1914, when with a membership of 352 it commenced its task, not merely of developing a general interest in botany in S. Africa, but also of assisting the establishment and development of a National Botanic Garden at Kirstenbosch. The value of the Society to the work of the Garden has been repeatedly acknowledged both by the former honorary director, the late Prof. Pearson, and the present honorary director, Prof. R. H. Compton. More than 3000*l.* has been handed over to the Garden from the Society's income, while special grants to specific pieces of developmental work have brought into being the rockery in the Dell, the pond in the Great Lawn, and a part of the Aloe Kopje. At the same time, still more valuable work has been done in interesting South Africans in the great scheme of which the shell as yet alone exists at Kirstenbosch, and many of the devoted collectors now supplying plants from all parts of S. Africa for the Garden were first brought into touch with the Garden through the Society. It is good to learn through its Journal (Part ix. for 1923) that its membership steadily increases and approaches its first thousand. The report for 1922 of the honorary director to the Trustees of the Garden has just been issued, and shows unmistakably the need there is for the efforts of such a society, which may with growing authority press more firmly the claims of these gardens upon the State. It is plain that the lack of capital prevents essential developments in the proper housing of a trained personnel, without which the real development of these gardens, an essential requirement for South Africa's future prosperity, cannot possibly take place.

THE American Chemical Society has undertaken the issue of two series of monographs—a "Scientific Series" under the editorship of Prof. W. A. Noyes, G. N. Lewis, L. B. Mendel, A. A. Noyes, and J. Stieglitz, and a "Technologic Series" under a Board of seven editors. This policy is one that carries with it certain risks. The mere fact that a book is required to be commercially successful is in itself some guarantee that the book is wanted, that a suitable author has been selected, and that the writing will be done carefully. When, however, a scheme is launched for stimulating artificially the production of books, there is a very serious risk that the standard created by these special conditions may be lower than when no outside stimulus to production is used. The conditions are, indeed, very similar to those which prevail in the publication of original papers. When a society has ample funds for publication, and is able to take the initiative in inviting authors to submit papers, it is only too probable that the standard of publication will fall below that which prevails when (for financial reasons or otherwise) the space available is so restricted that a very rigid censorship of papers is necessary. The particularly high standard now reached in the Journal of the American Chemical Society is indeed largely due to these limitations, which often prove a blessing in disguise, not merely to the readers of the Journal, but also to the authors of papers, who are compelled to adopt a high standard of clarity and conciseness. In its new enterprise, the American Chemical Society has been fortunate in securing a number of contributions which will bear comparison with work produced under more normal conditions; but there are already indications that unless a very stringent standard of writing and editing is maintained, inferior material may obtain publicity, as a direct result of the intervention of the Society in a field which has usually been reserved for private enterprise.

IT is announced in *Science* that the City of Philadelphia, through its board of directors of city trusts, made the annual presentation of the John Scott medal awards at a special meeting of the American Philosophical Society on the evening of April 10. The recipients were: Sir Joseph Thomson, for his researches on the physics of the electron; Dr. F. W. Aston, for his development of the mass-spectrograph and his studies of isotopes; Dr. C. Eijkman, of the University of Utrecht, for his researches on dietary diseases; Dr. Arthur Louis Day, director of the Geophysical Laboratory of the Carnegie Institution of Washington, for his researches on optical glass. The awards, which are made annually by the City of Philadelphia, are provided from the income of the John Scott fund, and they are made upon the recommendation of an advisory committee of five, consisting of representatives from the National Academy of Science, the American Philosophical Society, and the University of Pennsylvania.

AT the meeting of the Linnean Society held on May 3 Dr. John Isaac Briquet was elected a foreign member. Dr. Briquet received part of his early education in Scotland, and has always retained a pleasant recollection of his sojourn there. His botanical publications extend over the last thirty years, very largely upon Labiatæ and the botany of Switzerland. The most important works by which he is known in the botanical world are the "Texte synoptique," drawn up to guide the International Congress at Vienna in 1905, a quarto volume of 150 pages, and his "Prodrome de la flore de Corse," which began in 1910, and reached a second part in 1913. As director of the Botanic Garden at Geneva, conservator of the Herbarium belonging to that city (formerly "L'Herbier Delessert"), and professor in the University, his energies have been of late years largely absorbed in his administrative duties.

ON March 18 the National Acclimatisation Society of France conferred on Prof. A. Henry its large silver medal. This honour, which was bestowed in recognition of his services to forestry and to horticulture, could not have had a more worthy recipient. Prof. Henry's services to botany have not been less valuable. It is now nearly forty years since he began to collect plants in Central and Western China, largely over areas new to Europeans. Of his industry and efficiency in that work all the important herbaria in Europe and some in America contain ample evidence. By foresters and arboriculturists his name will always be held in high esteem as the joint author with the late Henry John Elwes of "The Trees of Great Britain and Ireland," for the botanical part of which he was responsible. Since the conclusion of that fine work Prof. Henry has taught forestry, first at the University of Cambridge, and latterly at the Royal College of Science, Dublin. He has made important investigations into the origin of hybrid trees, especially of poplars and the London plane, and recently has been studying the geographical races of Corsican pine and European larch, which has involved several journeys to their natural sites in Poland, the Carpathians, and other parts of Europe.

THE sixth annual general meeting of the Society of Glass Technology was held in Sheffield on April 18. Prof. W. E. S. Turner was re-elected president. The other officers elected were: *Vice-Presidents:* Mr. E. A. Coad-Pryor and Mr. W. J. Gardner. *Members of Council:* Mr. F. F. S. Bryson, Miss Violet Dimbleby, Major G. V. Evers, Col. S. C. Halse, and Mr. T. Teisen. *General Treasurer:* Mr. J. Connolly. *American Treasurer:* Mr. W. M. Clark. *Hon. Secretary:* Mr. S. English. *Auditors:* Mr. Edward Meigh and Mr. Dennis Wood. The president's address on "The Year in Review in the World of Glass-making" was taken as read. A general discussion followed on works organisation. Mr. W. W. Warren opened the discussion with a paper on "Organising for Production from Pot Furnaces." The case for "Tank-furnace Works Organisation" was presented by Mr. T. C. Moorshead, who said that the difficulties, troubles, and failures which beset the factory manager every day may all be traced to inefficiency on the part of the management, and probably to three things: (*a*) lack of foresight, (*b*) lack of a thorough knowledge of the factory operation, and (*c*) lack of initiative. The causes for these losses of efficiency can be grouped under five headings: (1) faulty material, (2) poor labour, (3) poor attendance, (4) large labour turnover, and (5) machine and mechanical breakdowns.

THE anniversary meeting of the Linnean Society will be held on May 24, when the High Commissioner for New Zealand will receive the Linnean gold medal on behalf of Mr. T. F. Cheeseman of the Auckland Museum, New Zealand.

DR. MORLEY FLETCHER has been nominated to represent the Royal College of Physicians at the commemoration of the centenary of the birth of Louis Pasteur, to be held in Paris on May 24 and in Strasbourg on May 31-June 1.

PROF. J. B. LEATHES's subject for the Croonian lectures of the Royal College of Physicians, to be delivered on June 7, 12, 14, and 19, is "The Rôle of Fats in Vital Phenomena." The FitzPatrick lectures, on the "History of Medicine," will be delivered in November by Dr. C. J. Singer.

A VACATION course for mechanics and glassblowers is to be held in the last half of August next in the workshops of the Physical (Cryogenic) Laboratory of the University of Leyden, of which Prof. H. Kamerlingh Onnes is the director. Information concerning the course can be obtained from Dr. C. A. Crommelin, The Physical Laboratory, Leyden, Holland.

THE council of the Royal Society of Edinburgh has awarded the Makdougall-Brisbane prize (1920-1922) to Prof. W. T. Gordon for his paper on "Cambrian Organic Remains from a Dredging in the Weddell Sea," published in the Transactions of the Society within the period, and for his investigations on the fossil flora of the Pettycur Limestone, previously published in the Transactions.

DR. FRANK SCHLESINGER informs us that Yale University Observatory has given a contract to the J. B. McDowell Company, Pittsburgh, U.S.A., for the optical parts of a 26-inch photographic telescope of thirty-six feet focal length. It is expected that this telescope will be in use within a year. It is to be erected at a site south of the equator, probably in South Africa or in New Zealand.

ON Saturday, May 19, at 2.30 P.M., a display of dancing will take place at the Alexandra Palace Theatre in aid of the Royal Northern Hospital. The performance deserves mention not only in view of its worthy purpose, but also because one of the items is a floral ballet written for the occasion by Dr. G. Rudorf, a chemist who is inspector in charge of non-metallic materials for the Air Ministry. The ballet, which lasts three-quarters of an hour, is scored for full orchestra, and will be conducted by the composer.

APPLICANTS for grants from the Chemical Society Research Fund must be made, upon a prescribed form, on or before June 1, addressed to the Assistant Secretary, Chemical Society, Burlington House, Piccadilly, W.1. The income arising from the donation of the Goldsmiths' Company is to be more or less especially devoted to the encouragement of research in inorganic and metallurgical chemistry, and the income from the Perkin Memorial Fund is to be applied to investigations relating to problems connected with the coal-tar and allied industries.

IN connexion with the Falkland Islands Government ship *Discovery* which is now being fitted out for marine researches, mainly on whales and whaling, in the Antarctic and other waters, a director of research will shortly be appointed. Candidates should preferably be graduates in natural science with a record of research work in biology and experience in the carrying out of scientific work at sea. Applications must be sent by June 15, upon a prescribed form if the applicant be resident at home (for those abroad the form is not required), addressed to the secretary of the *Discovery* Committee, Colonial Office, S.W.1.

MR. WILLIAM MUIR (538 Romford Road, London, E.7) sends us a note of a curious individual habit developed by a house-sparrow. During the greater part of two years this bird came to the sill of a particular window and tapped forcefully and persistently on the glass: this occurred daily during some periods and was maintained for hours at a time. Many sparrows were often present, but no more than the one ever took part in this performance.

MR. LOUIS STROMEYER, of Kolar Gold Field, Mysore State, South India, whose book "The Constitution of the Universe" was noticed in our issue of March 10, p. 319, has sent us a courteous protest against the review, particularly on the ground that it contained no direct detailed criticism of his theory. He contends that the review "would have been more to the point had it averred that the theory was incomprehensible and thus could not be criticised at all." This was substantially our view, with the addition that such parts as could be understood were so frequently wrong as to exclude the author from any right to serious and lengthy attention in our columns.

WE have received a letter from Mr. Leonard Hawkes with reference to Dr. Jeffreys' conclusion (noticed in NATURE of April 28, p. 585) that the Pamir earthquake of February 18, 1911, was the result of a great landslip. Mr. Hawkes directs attention to the view that the earthquake originated at a considerable depth below the surface and was itself the cause of the landslip. The point is dealt with by Dr. Jeffreys, who considers that the energy in the seismic wave was approximately equal to that which would be developed by the impact of the falling mass on the ground, and not greatly in excess, as it would have been if the rock-mass were loosened by a deeply-seated earthquake.

OWING to the proportions to which it has grown, the book department of Benn Brothers, Ltd., has been formed into a separate branch of the business, to be known as Ernest Benn, Ltd. Sir Ernest Benn, chairman of Benn Brothers, Ltd., will be chairman also of the new company, and the managing director will be Mr. Victor Gollancz, who for the past two years has been manager of the book department of Benn Brothers, out of which the new business has developed. This development will involve no change in general direction or financial control, and the address is the same as that of the parent company, namely, 8 Bouverie Street, London, E.C.4.

A SPECIMEN of a new fountain pen, called the "Research Fountain Pen," has been submitted to us by the manufacturer, Mr. A. Munro, 65 Preston Road, Winson Green, Birmingham, and we have used it with much satisfaction. The pen has two reservoirs, one of which is first filled with ink in the usual way, and the ink is afterwards transferred as required to a reservoir at the nib end by pulling out a knob and pushing it in again. The walls of the reservoirs are made of celluloid, so that the amount of ink in either of these can be clearly seen. It is claimed that the pen will not blot or leak, and that when it contains ink it will always write without being shaken. The pen certainly has some decided advantages, and so far as we have tested it the claims made are fully justified.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have in the press "The Expert Witness," by C. Ainsworth Mitchell, which will deal with, among other things, methods of identification by means of patterns on the feet; by the pores of the skin; by the detection of latent prints on paper, etc.; methods of estimating the age of ink in writing, and the application of X-rays to the identification of old masters.

Our Astronomical Column.

MAY METEORS.—Meteoric phenomena are usually somewhat scarce in May, but fireballs are often more abundant than in other months. The chief display of shooting stars, next perhaps in importance to the Aquarids of Halley's Comet, is a shower radiating from a position eastwards of Corona and near ζ Herculis at about $247° + 29°$. They are swift white meteors of average magnitude and moderately short paths, and have been most plentifully observed on about May 18 and 24, but further observations are required to determine the epoch of maximum. Fireballs are occasionally recorded from Scorpio and from the western region of Aquila in May, and a few very slow-moving meteors are seen in some years from near Capella. Although the meteors visible at this time of the year are not equal in number to those appearing on autumn nights, they are of considerable interest, and have never been sufficiently observed. The bulk of the observations in this department of astronomy has been accumulated in the last half of the year, and it follows that many of the meteoric systems visible in the spring season have been comparatively neglected.

IRREGULARITIES IN THE MOON'S MOTION.—Prof. Newcomb regarded the irregularity in this motion, the period of which is about $2\frac{1}{2}$ centuries, as the most perplexing enigma in astronomy. Mr. Walter Child, of Ashford, Middlesex, has made a suggestion which, although of no practical value, is worth mentioning, as it recalls one of the exact solutions of the 3-body problem. He points out that there is a conical space behind the moon, 83,000 miles long, which is perpetually invisible to us. In this space he locates a moonlet, which he supposes to influence the moon's motion. It is true that there is an exact solution of the 3-body problem with the bodies in a straight line. The distance behind the moon comes out almost 40,000 miles for a particle of small mass; it would be greater if the mass were comparable with that of the moon (Mr. Child's diagram places it much too near the moon). It is also true that the larger solar perturbations on the particle would be the same as those on the moon, since they depend only on the ratio of mean motions. But in view of the fact that the configuration would involve an incredibly exact adjustment, and is unstable, it is undeserving of serious consideration. Moreover, Mr. Child does not explain how the arrangement could give rise to perturbations of long period without causing any short-period ones. Strangely, he seems to imagine that the moon's librations stand in need of explanation; the extraordinary thing would be if they failed to exhibit themselves. They are the natural consequence of an appreciably uniform rotation combined with an orbital motion that is far from uniform; also of the inclination of the moon's equator to the orbit-plane.

Research Items.

Fire-making in the Malay Peninsula.—The fire-piston for the production of fire is used in a limited area among the Shans and people of Pegu in Burma, among the Khas and Mois, in the Malay Peninsula, Western Sumatra, Java, Bali, Lombok, parts of Borneo, and in Mindanao and Luzon. Seven specimens of the implement deposited in the Perak Museum are described by Mr. Ivor H. N. Evans in the Journal of the Federated Malay States Museum (vol. ix. Part 4). They are made of buffalo-horn, wood, and tin. Mr. Evans finds that in two out of three attempts he can make fire by means of it. The important part is the binding of a rag near the distal end of the piston, which acts as a washer, and prevents the escape of air. This must be so adjusted that it allows the piston to pass smoothly down the cylinder when the piston-head is struck sharply with the palm of the hand, and it must not be so tight that there is difficulty in withdrawing the piston fairly quickly, nor so loose that air can escape from within.

Records of British Coleoptera.—In the *Entomologist's Monthly Magazine* for April Messrs. J. C. F. and H. F. Fryer record a species of weevil, *Sitones gemellatus* Gyll., from Sidmouth. Its occurrence in this country was scarcely to be expected. The only British species of Sitones with which it could be confused is *S. cambricus*, which lacks the mesosternal tubercle, and has the sides of the prothorax much more rounded. The same writers also record the very local beetle *Dibolia cynoglossi* from Chatteris, Cambs., where it occurs on Galeopsis. It is an extremely agile insect, and so quick in its movements that it is almost impossible to take it by ordinary sweeping. This may perhaps account for the absence of records in Britain, Cambridgeshire being apparently the first addition to its known distribution since Mr. Donisthorpe's discovery of it at Pevensey in 1902. Messrs. Fryer further record *Chrysomela marginata* at roots of *Reseda lutea* (?) in the Breck sand district, near Mildenhall. The record is not conclusive evidence as to the food-plant of this insect, but it is suggestive that the larval instars may be spent on that plant.

A Taxonomic Study in the Cruciferæ.—Vol. 9, No. 3, of the Annals of the Missouri Botanical Garden is mainly occupied by a very full taxonomic study of the genus Thelypodium and its immediate allies (Chlorocrambe, Caulanthus, Streptanthella, Warea, and Stanleyella) by E. B. Payson, which has been carried out with the view of throwing light upon the phylogeny of the Cruciferæ. The genus is characterised by the possession of a gynophore or stipe which raises the ovary and fruit above the torus; while sometimes nearly negligible, in the species *T. laciniatus* and *T. eucosum*, the stipe is usually more than two millimetres long. In view of the fact that a very characteristic stipe is frequently found in the Capparidaceæ, a close study of the species of Thelypodium would seem to be a necessary step toward the fuller examination of a favourite phylogenetic view which relates the ancestral form of the Cruciferæ closely to the Capparidaceæ. It is further of interest to find that the characteristic septum traversing the pod in the Cruciferæ shows a striking peculiarity in the genus Thelypodium, although no developmental series can be traced in this character and its interpretation is very difficult. Extending nearly or quite from end to end of the pod, through the middle of the septum, is a broad region composed of cells elongated parallel to the marginal framework, and in this region the cell walls are more or less closely compacted. No species are now admitted to the genus Thelypodium that do not exhibit this type of septum.

A Journal of Helminthology.—The new *Journal of Helminthology*, edited by Prof. R. T. Leiper, is primarily intended as a medium for the prompt appearance of original communications by the staff of the Department of Helminthology at the London School of Tropical Medicine. Up to the present no British journal has dealt solely with this branch of parasitology, and Prof. Leiper is to be congratulated on this latest addition to scientific literature. The Journal is to be published bi-monthly, and the subscription is 25*s.* a volume. The first number (price 5*s.* net) contains five papers, three of which have a direct bearing on medical and veterinary science. Dr. A. J. Hesse contributes a paper on the free-living larval stages of *Bunostomum trigonocephalum*, a common intestinal nematode of the domestic sheep. Although this parasite is closely related to the hookworm, infection does not take place through the skin but by the mouth; moreover, the embryos at the infective stage exhibit negative thermotropism, whereas hookworm embryos are positively thermotropic. An epidemic of ascariasis on a skunk-farm has resulted in an inquiry, by Dr. T. Goodey and Mr. T. W. M. Cameron, into the morphology and life-history of *Ascaris columnaris*, a common parasite of the skunk. The results of their experiments indicate that the larvæ of *A. columnaris*, in the course of their migrations in the body of the definitive host, pass through the lungs, as is the case with *Ascaris lumbricoides* and *A. megalocephala*. Dr. M. Khalil re-describes a trematode (*Xenopharynx solus* Nicoll, 1912) from the gall-bladder of a "Hamadryad" (*Naja bungarus*); he also emends the genus Xenopharynx. Dr. G. M. Vevers contributes two papers. The first deals with the genus Paragonimus, which contains all the mammalian lung flukes of America and the Far East. He confirms Ward and Hirsch's view that the cuticular spines are the only trustworthy structures on which to distinguish the four species of the genus, and also suggests that more than one species occurs in man. His other paper contains a descriptive account of some new helminths from British Guiana.

Linkage in Sweet Pea.—In a paper on linkage in the sweet pea (*Lathyrus odoratus*), Prof. R. C. Punnett (*Journ. Genetics*, vol. 13, No. 1) reviews the work begun by Bateson and Punnett nearly twenty years ago, much of which is now classical in the history of genetics. He considers the relation between the number of linkage groups and the haploid number (7) of chromosomes, and concludes that the two will eventually be found to correspond. The numerous pairs of characters such as purple-red corolla, long-round pollen, and erect-hooded standard are given new symbols according to the linkage group to which they belong, and provisional "chromosome maps" of five of the linkage groups are made, based on the percentages of crossing-over. The number of linkage groups at present appears to be eight, but there are several groups with as yet untested possibilities of low-grade linkage, and it is anticipated that the number of linkage groups will in this way be eventually reduced to seven, as the chromosome theory of heredity demands.

Destructive Distillation of Bones.—Mr. E. V. Aleksejevski, in the Journal of the Russian Physical and Chemical Society, 1921, vol. 53, describes a research he has carried out, at the request of the Russian Government, on the dry distillation of large quantities of bones which have accumulated in the towns of the Tersk district since 1914. He finds that the quality of the bone charcoal obtained is better if horizontal retorts are used, instead of vertical ones. The ammoniacal liquor produced by distillation from such retorts contains more than twice as much ammonia as was usually obtained by the old method. The bone charcoal left in the retorts has a medium carbon content, and possesses a high degree of efficiency as a decolourising agent, for which purpose it is used in the beet sugar industry. It may with advantage be used as a contact catalyst, as, for example, in the direct synthesis of phosgene from carbon monoxide and chlorine, or in any other reaction of gaseous combination. Its catalytic power is found in a number of cases to compare very favourably with that of cocoanut-shell charcoal, which is considered to be the most efficient carbon containing contact catalyst.

Correlation of Upper Air Variables.—Mr. P. C. Mahalanobis contributes two Memoirs to the Indian Meteorological Department (Volume xxiv. Part ii.) entitled "The Errors of Observation of Upper Air Relationships" and "The Seat of Activity in the Upper Air." He comes to the conclusion that Chapman's corrections to W. H. Dines's correlation coefficients are open to doubt. But he has fallen into error in stating that Douglas's coefficients are based on true heights. In a footnote in the Professional Notes of the Meteorological Office, No. 8, Douglas explains how he obtained his heights. He (Douglas), in the quotation given, merely meant that he did not use altimeter heights based on the erroneous supposition of a uniform temperature of 50° F. In the second Memoir Mr. Mahalanobis discusses the height at which the correlation coefficients between the five variables are numerically greatest and obtains a much lower value than 9 kilometres. However, he seems to have confused the T_m used by Dines, namely, the mean temperature between 1 and 9 kilometres, with the mean temperature between 0 to 9 kilometres, and this fully explains the discrepancies he finds. Leaving out the temperature of the first kilometre in forming the mean prevents the relationship between P_0, P_9, and T_m being a fixed one, whereas the relationships between the partial correlation coefficients given by Mr. Mahalanobis depend upon P_0, P_z, T_z being connected by a definite equation. If these three quantities be rigidly connected, the connexion is equivalent to reducing the independent variables from five to four, and as a matter of course the partial correlation coefficients involving the three related quantities must be 1 or −1, and the second and third order partials must take the form found by Mr. Mahalanobis.

Development Centres in the Photographic Plate.—It is well established that photographic development starts at definite points or "reduction centres" in the individual grains of silver bromide. Silberstein favours the view that the corpuscular nature of light is the cause of this, while others regard these centres as pre-existing in the grains. The practical importance of the matter is that, if the latter is true, the emulsion maker may eventually be able to control the production and sensitiveness of these centres, and perhaps even to isolate them. Mr. Walter Clark, of the British Photographic Research Association, gives some important results of his investigation of this question in the May number of the Journal of the Royal Photographic Society. He finds that a solution of sodium arsenite has no measurable reducing action on silver bromide produced by precipitation, and confirms the fact that a dilute solution of it applied to a plate renders the plate developable. This is evidence that there is in the plate something besides simple pure silver bromide, which is affected by sodium arsenite (as well as by light) to form development centres. By giving a plate a suitable exposure to light to render the centres developable and then treating the plate with chromic acid, the sensitiveness of the plate is reduced to a very low figure but always of the same order of magnitude if the action is thorough (the preliminary exposure is necessary). It appears probable that the chromic acid dissolves the "centres" produced by the exposure and that the low remaining sensitiveness is the sensitiveness of pure silver bromide.

Mass Spectra.—In a communication which appears in the May issue of the *Philosophical Magazine*, Dr. F. W. Aston gives an account of his work with the mass spectrograph to the end of 1922. The general technique has been in the main unchanged, but softer rays from the discharge tube are being used, and the photographic plates have had some of the emulsion dissolved from them to concentrate the sensitive grains more highly. Helium, nickel, lead, zinc, xenon, tin, iron, cadmium, thallium, selenium, tellurium, beryllium, aluminium, and antimony have been tested, and the constitution of nickel, tin, iron, selenium, aluminium, and antimony determined for the first time. Two new isotopes of xenon have also been discovered. Tin and probably iron show deviations from the whole number rule on the oxygen scale, and with hydrogen give three exceptions to that rule. A complete table of elements and isotopes determined by any of the positive ray methods up to the present time is given.

A French Oil-Well.—In the *Comptes rendus* of the Paris Academy of Sciences of March 19, M. Ph. Glangeaud gives a note of the oil-well of Crouelle, near Clermont-Ferrand, Puy-de-Dôme, about which some paragraphs have recently appeared in the Press. The well-log is an interesting one, particularly from the geological point of view, and much information has been obtained regarding the Oligocene facies of the district between the Puy de Crouelle and the better-known Puy de la Poix. The beds traversed seem to belong to the Upper Sannoisien and Lower and Middle Stampien stages of the system, and, according to M. Glangeaud, recall in many respects similar Oligocene beds at Pechelbronn; further, the prevalence of abundant organic material and the conditions of sedimentation are cited as being distinctly favourable circumstances to the formation and accumulation of petroleum. The well was carried to a depth of about 856 metres, but operations were subsequently interrupted by casing breaking at 787 metres, which, with consequent water trouble, curtailed developments. Notwithstanding this, M. Glangeaud regards the results as being among the most important and encouraging yet achieved in this district, still an unknown factor as regards oil potentialities. Certainly the oil obtained from the well, both in quality and quantity, seems to augur well for future developments in the area, though on general geological grounds one can scarcely be optimistic as to the possibilities of a large field being discovered in this region of France.

The Italian Society for the Advancement of Science.

THE Italian Society for the Advancement of Science is not so ancient an institution as the British Association, but its objects are identical with those of its elder sister, and its methods are in many respects the same. In its present shape it dates from 1908, and its twelfth general session was held at Catania on April 5-11. This was the first occasion on which the Society has visited Sicily, and it was evidently a matter of friendly rivalry between visitors and hosts as to which could do most to make the meeting a success. Naturally the ancient "Università dei Studi" of Catania was in the forefront, with its picturesque and convenient Palazzo in the centre of the city, and its numerous laboratories and affiliated institutes in other quarters. Some sections, however, were lodged in the municipal buildings which overlook the University Piazza; and the opening meeting was held in the spacious Bellini Theatre, only a few minutes' walk from that square. The Italian Society does not share the apprehensions of some critics of our own Association in regard to multiplication of "sections": it enjoys no less than twenty-one of these, and includes in its scope, not only the physical, biological, and statistical sciences, but also medical, legal, philosophical, and historical studies. This accords with the organisation of higher studies in the faculties of Italian universities, and certainly has the effect of bringing a wider diversity of members together, without evident disadvantages.

Two other points of contrast with the procedure of the British Association may be noticed at this point. The inaugural address was delivered, not by the president of the Society, Prof. Pietro Bonfante, but by an honoured guest, the Minister of the Interior, Signor Gentile, who was supported by representatives of the ministries of Public Works and Justice, the War Office, and by the Admiral of the local squadron representing the Italian Admiralty. Shorter addresses of welcome were given by the president, and by Dr. Alessandro Russo, Rector Magnificus of the University, but there was no specialist presidential address as with us, nor were such addresses given by the presidents of sections. The sections, being more numerous, were more specialist than with us, and the attendance at them smaller. There appeared to be no such apparatus of sectional committees as we have, and the sectional proceedings were delightfully informal, and correspondingly profitable. Papers were short and gave the main points only, leaving details to be elicited in discussion. There was little display of specimens or diagrams, and one could have wished for more frequent illustration of objects and sites.

The great variety of the sections was compensated also by the custom (which has been advocated from time to time in the British Association also) of grouping sections in three large "classes," essentially of the physical, biological, and humanist sciences, and devoting quite half of the programme on each working day to discourses of general interest, some delivered to a whole "class" of sections, which suspended their sectional meetings meanwhile, others to "reunited classes," *i.e.* practically to the Society as a whole. These more general lectures were admirably done, and in some instances led to animated discussion; exceptionally even to adjourned debate and to resolutions addressed to the Society as a whole, or to the Government. As the general, semi-general, and sectional parts of the programme alternated between morning and afternoon on different days, there was ample opportunity for local members to fit in a fair sample of the Society's work with their ordinary avocations.

Excursions and social intercourse were not forgotten. The *Regio Commissario* gave an evening reception; the Prefect of Catania gave another; there was a gala performance of Mascagni's opera *Il piccolo Marat*, conducted by the composer himself; there was a whole-day excursion round Etna, arranged through the Etnæan Railway Company, and admirably organised, both on the part of the *Congressisti* and on that of the townships on the route, which turned out in gala array with school children, banners, music, and lavish distribution of home-grown oranges. The Etnæans will long remember this invasion of the *scientisti* of the peninsula; nor will the foreign guests forget the evident pride and confidence of the peasantry in the men who are doing so much to make that *terra di lavoro* the paradise which it deserves to become. Another day was devoted to the beautiful and historic Syracuse, which is easily reached from Catania by train. More specialist excursions to factories, agricultural stations, and other local establishments were arranged for those who desired them. A serious exploration of Etna had to be postponed, owing to inclement weather, until after the meeting; but even those who are not mountaineers could appreciate the amazing film-record of a mid-winter climb to the crater-rim, and the numerous papers on the habits and products of "our mountain," which, in spite of its occasional tantrums, is regarded with a queer mixture of reverence and affection by the Catanians, and becomes an object of daily inquiry and observance even to the foreign visitor. Its full glory, however, is not revealed at Catania; for that, you must go to Syracuse on such a day, cloudless and exquisite in form and colour, as fell to the good fortune of the Congress excursion.

Italian hospitality is proverbial, and the authorities of the Province, of the city of Catania, and of the University welcomed the *Congressisti* with open arms. Visitors, and especially foreign visitors, will not easily forget the many acts of unsolicited attention and courtesy which occurred during their stay, or the evident friendliness with which the Italian Society for the Advancement of Science is regarded in the locality of this year's meeting. Not the least durable token of this interest is the enrolment in Catania of about four hundred new members of the Society.

JOHN L. MYRES.

Industrial Paints and the Health of the Worker.[1]

IT is unfortunate that a question as to the use or disuse of a paint which is, in essence, a matter of efficiency and industrial hygiene, should be complicated by international and labour politics and by trade interests. Such has, for many years, been the position of the white-lead question.

In Great Britain, at least, the weight of evidence is to the effect that for covering power and durability, especially in exposed positions, there is no white paint or paint base equal to white lead. The one serious drawback to the use of this and of other lead compounds which are dissolved by dilute acids is their

[1] Committee on Industrial Paints: Report of the Departmental Committee appointed to re-examine the Danger of Lead Paints to Workers in the Painting Trades, and the Comparative Efficiency, Cost, and Effects on the Health of Workers, of Lead and Leadless Paints, and to advise whether any modifications of the conclusions and recommendations of the Departmental Committees appointed in 1911 have become necessary. Pp. 66. (London: H.M. Stationery Office, 1923.) 2s. 6d. net.

undoubted poisonous character. So impressed were the two Departmental Committees appointed in 1911 to investigate the incidence of lead poisoning in the two largest trades concerned with painting—buildings and vehicles respectively—that they recommended that, except for special classes of work of very minor importance, the use of paints containing more than a very small percentage of lead compounds soluble in dilute acid should be prohibited.

During the War much experience was gained with many materials, and the mere omission to repaint so many buildings and other structures enabled much valuable information to be gained. In 1921 the Home Office found that the information collected in view of the consideration of the use of lead paints by the International Labour Organisation of the League of Nations, was not in the main in accord with the findings of the 1911 committees. Another Departmental Committee, with Sir Henry Norman as chairman, has therefore reviewed the whole question and come to rather different and, it may be said, more reasonable conclusions.

The Committee is satisfied that the specific illnesses of the paint trade are due to lead poisoning and not, as Sir Kenneth Goadby and Prof. H. E. Armstrong were inclined to maintain, to the fumes of turpentine or other hydrocarbon solvents. There certainly appears to be little evidence of chronic disease due to these substances when used apart from lead. The Committee considers it to be generally admitted that dust from the sand-papering of old or new paint-work is almost the only cause of lead poisoning. The introduction of a waterproof sand-paper and the prohibition of dry rubbing-down bids fair to remove this main cause, and rules as to cleanliness simple enough to be enforceable may dispel minor causes.

Sir Frank Baines, of H.M.'s Office of Works, was emphatic as to the superiority of white-lead paint over any substitute for outdoor painting of buildings. Analyses of scrapings from various public buildings confirmed the view that zinc oxide coatings had almost disappeared, exposing the old lead paint beneath. On the other hand, it must be pointed out that leadless paints seem to have given satisfaction when used on vehicles.

Great Britain is pledged to bring in legislation to give effect to the decisions of the Labour Organisation of the League of Nations, and the Committee has prepared draft regulations accepted by both sides of the Joint Industrial Council. It seems doubtful, in view of much of the evidence, whether the prohibition of white lead in internal painting should be strictly enforced, but on the whole, the regulations are salutary and should reduce the number of cases of lead poisoning, while a system of medical inspection should prevent mild cases from becoming chronic.

Lord Askwith in the *Times* of April 4 points out certain international aspects of the question, and expresses the hope, partly on economic grounds, in view of the possibility of minimising danger from white lead, that prohibition of its use for internal painting in 1927 may not be enforced.

The Duddell Memorial of the Physical Society.

In October 1920 the council of the Physical Society of London decided that Mr. W. du B. Duddell's memory should be perpetuated, and invited the council of the Institution of Electrical Engineers and the council of the Röntgen Society to join in forming a committee to collect funds for the Duddell memorial. The following were the members of the Memorial Committee so formed: Sir William Bragg, Sir Horace Darwin, Sir R. T. Glazebrook, Dr. R. Knox, Prof. T. Mather, Mr. Roger T. Smith, and Mr. Robert S. Whipple. A gratifying response was made to the appeal, nearly 700*l*. being subscribed.

The council of the Physical Society, feeling that Duddell's name will always be associated with the development of scientific instruments, has decided that the memorial shall take the form of a bronze medal to be awarded periodically to those who have advanced knowledge by the invention or design of scientific instruments or of the materials or methods used in their construction. The interest on 400*l*. (invested in 5 per cent. inscribed stock) will be given to the recipients of the medal.

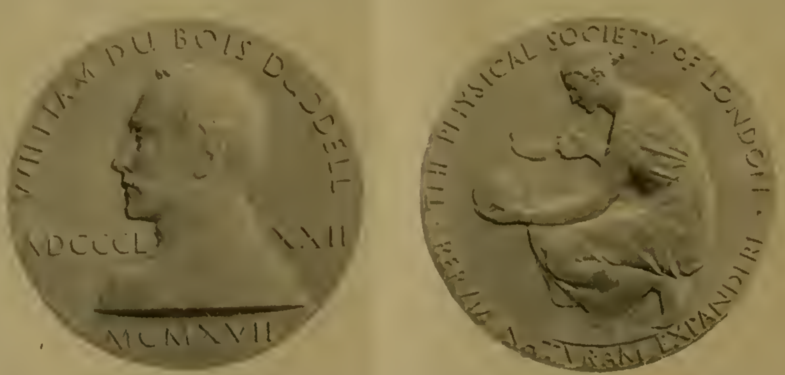

Fig. 1. Duddell Memorial medal to be presented periodically by the Physical Society of London to those who have advanced knowledge by the invention or design of scientific instruments or of the materials or methods used in their construction.

At a meeting of the Physical Society held on Friday, May 11, Sir William Bragg as chairman of the Memorial Committee handed to Dr. Alexander Russell, the president of the Society, the dies for the medal and the scrip for the investment. Sir Richard Glazebrook, speaking also on behalf of the subscribers to the Memorial Fund, dwelt on Duddell's ability and labour.

Dr. Russell, in accepting the dies, etc., on behalf of the Society, expressed his pleasure that Duddell's work, and especially his work in connexion with the Society, should be perpetuated by a memorial of this kind.

The medal (Fig. 1), which is in bronze, was designed by Mrs. Mary G. Gillick. The obverse shows the head of Duddell in profile, with his name "William Du Bois Duddell" written above it. The dates of his birth and death —1872 and 1917—are placed in Roman characters horizontally across the medal. The artist has succeeded in showing in a striking manner the alert energy of Duddell as well as the erectness of his carriage. The reverse represents the quest of science for knowledge, a symbolic figure, throwing light on the mysteries of the earth. Above the figure the words "The Physical Society of London" appear, while below is the motto "Rerum naturam expandere," which may be freely translated, "To elucidate the causes of things."

The Sir Ralph Forster Tablet at University College, London.

VISCOUNT CHELMSFORD, chairman of the University College Committee, unveiled, in the presence of a distinguished audience representative of chemical teaching and of chemical industry, a marble tablet placed in the hall of the Chemistry Laboratories at University College to commemorate the munificent donations made by Sir Ralph Forster, Bt., towards the erection and equipment of these laboratories.

Lord Chelmsford, in his opening speech, referred to the old Chemistry Laboratories erected in 1871 by the late Prof. Alexander Williamson, which, though in their time the latest thing in chemical laboratories, had proved quite insufficient and inadequate botn in space and in equipment. They had, nevertheless, proved the scene of some of the greatest discoveries made by the late Sir William Ramsay, ably supported by Prof. Collie, Prof. Baly, and Prof. Travers. He recalled how Sir Ralph Forster had intervened at the last moment with a contribution of 4500*l.* just two days before the option for the purchase of the present site of the Chemistry Laboratories was to expire on January 31, 1911. At a later date, when the question of the funds for the erection and equipment of the buildings arose, Sir Ralph Forster had again come forward, this time with a donation of 30,000*l.* Lord Chelmsford dwelt upon the need for private benefactors to carry on the work thus begun, and mentioned that a sum of 15,000*l.* is still needed to complete the physical chemical equipment and the electrical installation in the new laboratories.

The Vice-Chancellor of the University of London, Mr. H. J. Waring, speaking in the name of the Senate of the University, expressed to Sir Ralph Forster the grateful thanks of the University for his striking and timely munificence. The Vice-Chancellor developed further the theme already mentioned by Lord Chelmsford, namely, the urgent need for private benefactors for university education in this country, to supplement the funds devoted to university education by the Treasury through the University Grants Committee.

Prof. J. Norman Collie gave an interesting account of the conditions which prevailed in the old Chemistry Laboratories when Sir William Ramsay and he began their work there in 1887, and referred to the work which had been carried out in those laboratories during the time when Sir William Ramsay and himself had worked in them from 1887 until 1912.

Sir Ralph Forster replied, expressing his deep appreciation of the recognition given to his help by the perpetuation of his name in connexion with University College. He expressed his sense of the importance of the work which is being carried on at University College, not only in chemistry but also in other branches of study. Sir Ralph Forster explained that from his earliest days he had been deeply impressed by the need for providing the best facilities for university education for young men of promise, especially in science, and that it was this feeling which led him to come forward and supplement the efforts which were being made at University College for the provision of chemical laboratories of the best and most up-to-date character.

After the speeches, the company adjourned from the large Chemistry Theatre to the Hall of the Chemistry Laboratories, when the unveiling was performed by Lord Chelmsford. The tablet, which was designed by Prof. F. M. Simpson, is of white marble surrounded by a green marble border. It bears the inscription: "The Ralph Forster Organic Chemistry Laboratory, so named in grateful recognition of the generosity of Sir Ralph Forster, Bt. MCMXI."

Cinema Film of the Total Eclipse of the Sun at Wallal, Australia, September 21, 1922.

THERE have been in the past several proposals to take a cinema film of a total eclipse of the sun, but the first real outcome of these proposals is the film now being shown at the Royal Albert Hall. The pictures illustrate the experiences and the work of the astronomers of the expedition, under Prof. W. W. Campbell, to Wallal, on the north-west coast of Australia, from the time they left Perth until after the eclipse. The journey to Broome was made on the S.S. *Charon*, and afterwards on the lugger *Gwendoline*, towed by a lighthouse tender, to Ninety Mile Beach. On account of the great rise and fall of the tides, the ship had to anchor five miles out, and the astronomers with all their baggage had to be landed in boats through the surf. The equipment was then transported on donkey waggons to the site selected for the camp, and in this work the aboriginal inhabitants of the country, both men and women, gave considerable assistance. The large amount of dust, which rose in clouds wherever there was any work being done, caused great inconvenience. Nevertheless a large camp was soon set up and the assembling of the instruments commenced. The process of erection of the tower telescope and of the equatorials and cœlostats, as well as the various rehearsals in changing plates and uncovering object-glasses, are well illustrated. The part of the film showing the solar corona is good, considering that it was taken with a cinema lens, but a better picture could easily be constructed from the negatives taken by the eclipse party.

The film will enable those who are interested in scientific work to appreciate the difficulties which eclipse observers often have to face. Large and cumbersome instruments have to be transported long distances and often erected in almost inaccessible places where little or no skilled labour can be obtained. The conditions at Wallal were probably more difficult than usual, but were bravely faced and overcome. A wireless apparatus was erected to keep the eclipse party in communication with the outside world, and a weekly aeroplane service was instituted. The film is well worth seeing by those interested in the work of scientific expeditions. It would have been too much to expect that a film of this kind, taken under such difficult conditions, would come up to the standard of the films produced by special actors in artificial conditions. However, the fact that the actual work of the astronomers is interspersed with pictures illustrating the life of the natives should make the film one of more general interest. With these additions the showing of the film takes a little over an hour. The attempt to produce a film showing the actual work of a scientific expedition is one which deserves every encouragement and we wish it every success.

University and Educational Intelligence.

BIRMINGHAM.—Applications are invited for the James Watt research fellowship in the thermodynamics of internal combustion engines. Particulars of the fellowship, which is of the annual value of 220*l.*, may be obtained from the Dean of the Faculty of Science of the University. The latest date for the receipt of applications is May 31.

CAMBRIDGE.—The University proposes to confer honorary degrees on Viscount Grey of Fallodon, Lord Plumer, the Rt. Hon. Stanley Baldwin, Chancellor of the Exchequer, Sir Aston Webb, president of the Royal Academy, Mr. M. C. Norman, governor of the Bank of England, Sir Arthur Evans, Prof. H. A. Lorentz, Dr. W. H. Welch, and Prof. Niels Bohr.

The vacancy in the newly founded professorship of animal pathology is announced.

LONDON.—Notice is given that applications for grants from the Thomas Smythe Hughes Fund for assisting medical research must be sent not later than June 15 to the Academic Registrar, University of London, South Kensington, S.W.7, accompanied by the names and addresses of two references.

MANCHESTER.—The council has appointed Mr. L. J. Mordell as Fielden professor of pure mathematics as from September next. Mr. Mordell, who was awarded the Smith's prize in 1912, has won a high reputation as an investigator in the theory of numbers, and has been invited by the University of Chicago to deliver a course of lectures in that subject during the present summer.

Lord Crawford has been nominated as Chancellor in succession to Lord Morley of Blackburn.

WE learn from the *Times* that the University of Cracow has conferred on the Earl of Balfour the degree of Doctor of Philosophy, and the Polish Minister, who was accompanied by Prof. R. Dyboski (representing the Senate of the University), recently called upon Lord Balfour to present the diploma.

THE Society of Merchant Venturers, Bristol, offers for competition fifteen scholarships tenable in the day classes of the faculty of engineering of the University of Bristol, which is provided and maintained in the College. Candidates must be not less than seventeen years of age and must have matriculated. The scholarships provide free tuition: one is open to pupils in secondary schools; three are restricted to pupils of secondary schools in Gloucestershire, Somerset, and Wiltshire; ten are restricted to the sons of officers in His Majesty's service who were killed in the War; and one is restricted to a son of a citizen of Béthune who has passed either the B. ès L. or the B. ès Sc. examination. A War memorial scholarship is also offered, with a preference to a candidate who needs pecuniary help and is the son of a former student who lost his life during the War. Further particulars can be obtained from the Registrar of the Merchant Venturers' Technical College, University of Bristol.

THE programme of the summer meeting arranged by the University of Oxford Delegacy for the Extension of Teaching, to be held on July 27–August 16, contains a noteworthy list of lectures. The main subject of study will be "Universities, Medieval and Modern, and their place in National Life," and in this connexion there will be lectures on various universities, on the relation of the university to the State and to the community, and on the place of science in university study, the last by Prof. H. H. Turner. The special economic subject of the meeting will be "The Social and Economic Problems of English Country Life," and Sir Daniel Hall is giving an introductory lecture on "Agriculture and the Community." Among the lectures in this course is one by Prof. W. Sommerville on "Grasslands." Provision has also been made for a special course on the methods of research in organic chemistry. The course has been arranged to meet the wishes and needs of the science teachers in secondary schools, and will be under the supervision of Dr. F. D. Chattaway. Inquiries should be addressed to the Secretary of the Delegacy, Rev. F. E. Hutchinson, University Extension Delegacy, Examination Schools, Oxford, and marked "Summer Meeting."

IN NATURE of August 26, p. 298, reference was made to the department established by the University of Calcutta for the study of poverty, and particularly unemployment, from a purely scientific point of view apart from class or political bias of any kind. We have now received from the department the first two of a series of lectures by Capt. J. W. Petavel, principal of the Kasimbazar Polytechnic Institute, on "The New Social Question"—the question, namely, how to apply "quite practically and as a matter of business" those principles of co-operation in industry which socialists have proposed to apply by establishing State socialism. The lecturer restates the "Deserted Village" problem, which is of special interest at the present time in India. There are as yet comparatively few town-dwellers, but there is a steady and increasing drift from the country districts to centres of manufacturing industry, and the problem of unemployment of middle-class townspeople is acute. The lecturer suggests that a solution can be found in a system of combined field and factory labour colonies, the homesteads being located along radial lines of communication converging on the factories. The first step is to be the establishment of schools combined with farms and workshops within easy reach of towns. A substantial amount of the pupil's time at school would be devoted to productive work. The Vice-Chancellor of the University and many other prominent citizens of Calcutta were so impressed by Capt. Petavel's arguments that they issued an appeal last year for support for such a scheme.

THE report of the University of Leeds for 1921–22, issued recently, deals with a number of topics of more than local interest. It includes a record of resolutions passed in January 1922 at a conference at Leeds of the six universities of the midlands and north of England defining the factors of university evolution which ought, in the opinion of the conference, to be considered before any institution is raised to the status of a university, and formulating opinions regarding several other questions of university policy. The resolutions were submitted to and discussed with the University Grants Committee. There is also a copy of an important letter addressed by the same universities jointly to the Prime Minister in December 1921 stating the case against the reduction of the Treasury grants to universities and university colleges in Great Britain. Appended to this is a comparative table of grants by local education authorities to each of the six universities in 1913–14 and 1921–22. It shows increases amounting in the aggregate to nearly 100 per cent.—from 74,000*l.* to 136,000*l.*—the most striking being in the grants to Durham (5501*l.* to 16,346*l.*) and Sheffield (17,226*l.* to 39,691*l.*). The number of full-time students at Leeds in 1921–22 was 1646—the highest on record and 150 per cent. higher than in 1913–14. Reviewing the University's finances, it is stated that raising the fees payable by students has for the time being saved the situation, but that a considerable falling off in the number of students must be looked for partly owing to the departure of the ex-service students and partly on account of the limit placed by the Board of Education on the number admitted to the Training Department. Among developments at the School of Medicine the report mentions the institution of a Diploma in Nursing, and claims that Leeds is the first university in this country to introduce such a diploma.

Societies and Academies.

LONDON.

Royal Society, May 10.—A. **Fowler**: The series spectrum of trebly-ionised silicon (Si IV). Numerous new lines of silicon have been observed and have been classified in four groups representing successive stages of ionisation. They have been designated Si I, Si II, Si III, and Si IV. The spectra consist alternately of triplets and doublets, and the series constant has successive values N, 4N, 9N, and 16N. For the series of Si IV the series constant is 16N. The spectrum is similar to that of neutral sodium, Na I. Including Paschen's recent work on Al III, and the author's previous work on Mg II, which also have spectra similar to that of Na I, data are thus available for the comparison of the spectra given by four similarly constituted atoms, which differ mainly in the charge of the nucleus. The highest limit of the Si IV system is 364,117, corresponding to an ionisation potential of 40·6 volts.—Sir R. **Robertson** and W. E. **Garner**: Calorimetry of high explosives. A calorimetric bomb was devised in which high explosives could be brought to true detonation under comparable conditions as regards density of loading and confinement, without using a large quantity of explosive. In an explosive balanced in respect to total combustion, where it is possible to calculate values for heat of detonation and volume of gases, the results agree with theoretical calculations. The influence of the higher heat of formation of phenol with respect to toluene is reflected in the similar values for heat of detonation of trinitrophenol and of trinitrotoluene, although the latter has much less oxygen for its combustion. The nature of the products, and the effect of conditions under which detonation is carried out on heat generated, and gaseous reactions involved, chiefly with regard to liberated carbon, are discussed.—H. S. **Hele-Shaw**: Stream-line filter. Very thin films of coloured liquid, or liquid containing matter in very fine suspension, either lose their colour in one case, or become deprived of their suspended matter in the other, on entering such thin films. In the new form of filter, sheets of paper made impervious to the fluid containing the suspended matter are arranged in a pack. By perforating the pack with a large number of holes it is possible to get the equivalent of a number of sources and sinks. This was obtained by using high pressures, so as to force the matter from one row of holes, acting as sources between the interstices of the paper, to another row of holes, each hole in the latter acting as a sink. Filtration can be made sufficiently rapid for actual use. The colouring matter of various dyes, from what were apparently complete solutions, can be removed, and substances like peat-water rendered clear and colourless.—F. W. **Aston**: A critical search for a heavier constituent of the atmosphere by means of the mass-spectrograph. The residues absorbed in charcoal from more than 400 tons of air were dealt with. Analysis with the mass-spectrograph gives a negative result and indicates that such an element certainly does not exist to the extent of 1 part in 10^{15} of air, and probably not to the extent of 1 part in 2×10^{16} parts of air by volume. Faint bands observed in the region corresponding to masses 150 and 260 were found. The first is due to a complex molecule of mercury with a multiple charge, but no conclusion is reached in the case of the other. The results of the experiments are not in accordance with the presence of molecular krypton and xenon in the air, recently suggested.—H. E. **Armstrong**: The origin of osmotic effects. IV.—Hydrono-dynamic change in aqueous solutions. "Water" is a complex saturated with the gas *Hydrone*, OH_2. Primarily, hydrone is the sole potentially "active" constituent, but it becomes actually active only under conditions which suffice to determine electrolytic change. The vapour pressure either of water or of a solution is the measure of the proportion of free hydrone molecules present in the liquid. Although the vapour pressure is lowered in the presence of any solute, the solution acquires attractive properties. The internal activity is increased while external activity is diminished. The effect produced may be ascribed to an interaction of molecules of the solute and those of hydrone. From non-electrolytes (under the influence of conducting impurity) a simple hydrol is formed $M\langle{}^{H}_{OH}$, only a single molecule of hydrone being "distributed" upon the molecule of the solute, whatever its magnitude. In the case of potential electrolytes, a reciprocal interchange of radicles of salt and hydrone is to be postulated. Not only is the solute hydrolated, but it is also distributed upon hydrone, the salt X′R′ giving rise initially to the reciprocal systems

$$R\,X\langle{}^{H}_{OH} \quad \text{and} \quad H_2O\langle{}^{R}_{X}$$

As the concentration is lowered, under the influence of hydrone, the complex $R\,X\langle{}^{H}_{OH}$ is more and more converted into *hydronol*, $H_2O\langle{}^{OH}_{H}$. Ultimately the solution contains the solute only in the form $H_2O\langle{}^{R}_{X}$ together with an equal number of molecules of hydronol. The "distributed" reciprocal complexes, including hydronol, are the electro-chemical agents in a solution. The negative radicle in such complexes has greater residual affinity than it has in the original simple molecules. The osmotic pressure manifest in an aqueous solution is the pressure exercised by the extra molecules of hydrone attracted into it by the "distributed" complexes, one by each complex, acting as though they were present in the gaseous state. In short, osmotic pressure developed within an aqueous solution, whatever the solute, has its origin in one and the same cause and is properly spoken of as *hydrono-dynamic*—if the word be permissible: indeed, this term may be used as expressive of the general activity of water, *electro-chemical and osmotic*.—H. E. **Armstrong**: Electrolytic conduction: sequel to an attempt (1886) to apply a theory of residual affinity. Referring to the distinction which he drew in 1886 between simple and composite electrolytes—the former being electrolytes *per se*, the latter solutions of "salts"—the author directs attention to the diverse behaviour of the silver and lead haloids on electrolysis; the current being carried, as it were, by the metallic ion of the silver and by the halogen of the lead compound. The conclusion is drawn that the salts of the two metals differ in structure—perhaps thus:

$$\begin{array}{ccccc} Ag & Ag & Ag \\ I - & I - & I \\ | & & | \\ I - & I - & I \\ Ag & Ag & Ag \end{array} \qquad \begin{array}{ccccc} Cl_2 & & Cl_2 & & Cl_2 \\ Pb & - & Pb & - & Pb \\ | & & & & | \\ Pb & - & Pb & - & Pb \\ Cl_2 & & Cl_2 & & Cl_2 \end{array}$$

The assumption is made that the primarily active unit is the fundamental molecule, and that the circuit is formed by these molecules being coupled with (distributed at) the electrode face and with the complex molecules. A similar interpretation is applied to aqueous solutions.—R. W. **Wood** and A. **Ellett**: On the influence of magnetic fields on the polarisation of resonance radiation. In the case of the resonance radiation of mercury and sodium vapour, strong polarisation of the light can be produced by weak magnetic fields properly orientated, and the polarisation of the light normally present can be destroyed by a magnetic field in a certain orientation. The field strength necessary for the destruction of the mercury vapour polarisation is less than one Gauss.—W. G. **Palmer**: A study of the oxidation of copper and the reduction of copper oxide by a new method. A film of copper about 1/1000 mm. thick is prepared by chemical means on a china-clay rod, which is then clamped in a circuit carrying a small current at constant E.M.F. The film is oxidised at 130°-210° C. with gaseous oxygen at pressures up to 1 atmosphere, and the rate of oxidation determined by measurements of the resistance of the film. The rate of oxidation is proportional to the second power of the amount of metal in the film, and, for pressures up to 300 mm., to the square root of the oxygen pressure. Between 170° and 190° C. the temperature-coefficient of the oxidation is negative owing to the simultaneous oxidation of cuprous oxide first formed. When hydrogen or carbon monoxide is mixed with the oxygen the rate of oxidation is greatly enhanced after a short initial period. In the reduction of copper oxide by hydrogen and by carbon monoxide, both gases are adsorbed on the metal and reduce adjacent oxide, but with hydrogen the water formed also adheres to the metal. The rate of reduction in both cases is directly proportional to the amount of metal present, an additional term in the case of hydrogen representing the action of the water.—E. A. **Fisher**: Some moisture relations of colloids. II.—Further observations on the evaporation of water from clay and wool. The curvature occurring in the evaporation curves of clay soils, formerly attributed to shrinkage, is not found with ball clay, although this substance also shrinks on drying. This type of curvature appears only in the evaporation curves of such materials as soils, which are mixtures of colloidal and non-colloidal substances, and is due to the simultaneous evaporation of imbibitional water held by the colloidal and of interstitial water held as water-wedges between the soil grains. The former evaporates at a practically constant rate, while the latter evaporates at a rapidly diminishing rate. The linear rate-curve of wool is not inconsistent with a real shrinkage occurring, although no such shrinkage has been demonstrated.

Faraday Society, April 23.—Sir Robert Robertson in the chair.—J. H. **Shaxby** and J. C. **Evans**: On the properties of powders; the variation of pressure with depth in columns of powders. In the theoretical section an approximate mathematical solution is given of this problem for the case of powder in a cylindrical tube and in the absence of external pressure and where the surfaces of equal pressure are plane. The following equation is arrived at, $p = p_m(1 - \epsilon^{-kx})$, where p is the pressure at depth x, p_m is equivalent to $p g\mathrm{R}/2c$ and μ to $2c/\mathrm{R}$; p being the mass per unit volume of the powder, R the radius of the tube, and c a constant depending on the coefficient of friction. In columns of lead shot and of powder, the absolute value of the pressure appears to depend on the state of packing of the column, and the resulting shape of the equal-pressure surfaces.—E. E. **Walker**: On the properties of powders. (1) The compressibility of powders. The resistance offered by powders to static loads and to blows from a falling weight has been investigated. (2) The distribution of densities in columns of compressed powders. Local densities in columns of compressed powder have been measured, and from the form of the density gradient curve the distribution of pressure in a column of compressed powder has been deduced.—E. K. **Rideal**: On the rate of hydrogenation of cinnamic and phenyl-propiolic acids. Solutions of sodium phenyl-propiolate and sodium cinnamate undergo hydrogenation at equal rates of hydrogen uptake in the presence of palladium sol in large quantities. The rate of hydrogenation is governed by the rate of supply of hydrogen to the palladium in the liquid and is proportional to the square of the shaking speed, the reaction velocity being of zero order. Both old and fresh sols commence reaction with a velocity curve of zero order, but terminate in a reaction velocity curve of the first order. The salts undergoing hydrogenation as well as the hydrogen are adsorbed. The adsorbed salt remains on the surface until completely hydrogenated; thus the rate of hydrogenation of phenyl-propiolate is the same as that of the cinnamate, the former taking up two molecules of hydrogen in the same time as the latter takes up one.—Leonard **Anderson**: Note on the coagulation of milk by acid. Addition of hydrochloric acid to milk of various dilutions causes precipitation of casein, the amount of precipitation increasing with increasing amounts of acid until a maximum rate of settling of the casein occurs which is inversely proportional to the dilution of the milk. The fat globules are mechanically carried down by the casein curd. At higher concentrations of acid the casein goes into solution again, and at still higher concentration is again precipitated; this is the salting out of the casein chloride by hydrochloric acid. Emulsions of benzene and olive oil in casein solution behave in an analogous manner to milk with respect to acid and alkali. Casein is probably the protective agent for the particles of fat in milk.—A. **Taffel**: The temperature of maximum density of aqueous solutions. The decrease in the total volume which occurs when 1 gram of a substance is dissolved in water at a definite temperature has been termed the "solution-contraction" for that substance at that temperature and concentration. Solution-contraction increases as the temperature at which solution is brought about is lowered. With methyl, ethyl, and propyl alcohols, the solution-contraction decreases with the temperature. The temperature of maximum density of the solution is below 4° C. The specific effect of ions and molecules on the depression of the t.m.d. of water results from their specific solution-contraction.

Zoological Society, April 24.—Prof. E. W. MacBride, vice-president, in the chair.—Baron F. **Nopcsa**: On the origin of flight in birds.—E. C. Stuart **Baker**: Cuckoos' eggs and evolution.

Royal Microscopical Society (Industrial Applications Section), April 25.—Prof. F. J. Cheshire, president, in the chair.—W. N. **Edwards**: The microscopic structure of coal. The study of the microscopic structure of coal, though dating back to Henry Witham (1833), made rather slow progress until recent years owing to the difficulty of preparing thin sections. Much detailed work has now been done by Lomax, Hickling, Stopes, Thiessen, and others, which has considerably widened our knowledge of the mode of formation of coal, and has important economic bearings on questions of fuel economy, seam correlation, spontaneous combustion and inflammability of coal dust. Stopes recognises four fairly distinct constituents with different physical and chemical characteristics in bituminous coal. The "anthraxylon" of Thiessen, regarded as being derived from wood rather than from general plant debris, seems to correspond on the whole to the clarain of Stopes, whose classification is based on present constitution rather than probable derivation.

Physical Society, April 27.—Dr. Alexander Russell in the chair.—J. W. **Ryde** and R. **Huddart** (Research Staff of the General Electric Co.): The analysis of bubbles in glass. In order to distinguish bubbles generated by chemical action in glass from those introduced by mechanical processes, spectroscopic tests are made for the presence of nitrogen. To liberate the gas from the bubbles a specimen of the glass is placed in one limb of a quartz U-tube containing mercury; the glass is heated and disintegrated by sudden cooling, the tube being plunged into cold water at the same time that the mercury is thrown on to the glass.—H. P. **Waran**: A simple regenerative vacuum device and some of its applications. Residual traces of air foul the vacuum above the mercury column in syphon gauges and other devices. A bent capillary tube ending in a bulb attached to the top of a siphon gauge will remedy this. It enables the air to be pushed repeatedly into the vacuum of this bulb, the mercury at the bottom of the capillary preventing the subsequent return of the air. The device is regenerative in the sense that, irrespective of any progressive fouling of the vacuum, a fresh-air-free vacuum is automatically created by it every time it is brought into action.—H. **Shaw** and E. **Lancaster-Jones**: Application of the Eötvös torsion balance to the investigation of local gravitational fields. In view of the sensitivity of the balance, which measures derivatives of gravity of the order of 10^{-9} C.G.S. units, it was anticipated that a gravitational survey of the laboratory would disclose the varying effects of the neighbouring masses of the walls, pillars, etc. The consistency of the results obtained at each station and their general agreement with the calculated effects exceeded expectations, as the local gravitational field varied so rapidly that the theoretical assumption of a uniformly varying field in the neighbourhood of a station was obviously vitiated.—L. F. **Richardson**: An electromagnetic inductor. Two bicycle wheels are mounted vertically and co-axially, and are driven in opposite directions by a 4-volt motor, the driving band being constituted by an endless wire. The electromotive forces generated by the revolution of the wheels in the earth's field are thus added, the rims of the wheels being electrically connected through the driving wire. The speed of the wheels is found by counting the revolutions against a stop-watch, one of the spokes being marked for this purpose, and from this speed and the length of a spoke the E.M.F. can be found in terms of H.—F. Ll. **Hopwood**: Pulfrich's experiment demonstrating time-lag in vision. The time-lag in visual perception is greater for dimly than for brightly illuminated objects. A pendulum carrying a glow lamp at its lower end swings over a second glow lamp fixed immediately below the mid position of the swinging lamp. Both are viewed with one eye, while in front of the other eye a metal disk perforated at its centre is placed. The pendulum then appears to be a conical instead of a plane pendulum, the apparent direction of rotation changing when the disk is transferred from one eye to the other. The image seen by the obstructed eye corresponds to an earlier position of the swinging lamp than does the image seen by the free eye, in consequence of the greater time-lag in the former case.

Paris.

Academy of Sciences, April 23.—M. Albin Haller in the chair.—Henri **Lebesgue**: The singularities of harmonic functions.—G. **Bigourdan**: The propagation of Hertzian waves over great distances: the order of magnitude, in time, of the perturbations of the propagation. An analysis of the measurements obtained at five observatories of the time taken by the 300 rhythmic signals (about 4 m. 53 sec.) sent out by the military wireless station at Paris each day. The observed times are not affected by the atmospheric perturbations, nor by the receiving apparatus.—A. **de Gramont**: The use of the oxyacetylene blowpipe in spectrum analysis. Applications to mineralogy. Compared with the oxyhydrogen or oxygen-coal gas flames, there are more lines in the spectra, and the time of exposure can be shortened. Reproductions of flame spectra obtained by this method from chromite, oligiste, and lepidolite mica are given.—C. **Guichard**: The triply indeterminate systems of Ω circles.—L. **Cuénot** and L. **Mercier**: The flight muscles in the winged forms of *Drosophila melanogaster*.—N. **Gunther**: An auxiliary theorem.—Paul **Lévy**: The application of the derivative of non-integral order to the calculus of probabilities.—René **Lagrange**: Varieties without torsion.—Maurice **Fréchet**: The distance of two *ensembles*.—Alf. **Guldberg**: The problem of drawing from lottery urns.—Stanislas **Millot**: The probability of the existence of biological laws.—D. **Riabouchinski**: The paradox of d'Alembert.—M. **Sudria**: The determination of the position of flexure in a bent beam.—A. **Leduc**: A new equation of state for gases. The expression

$$p = \frac{RT}{M}\left[\frac{v}{(v-a)^2} - 3\cdot16\frac{a}{(v+a)^2}(4^x - 1)\right],$$

which is based on compressibility experiments between 1 and 2 atmospheres only, has been applied to the results of Amagat for carbon dioxide. Over a pressure range between 31 and 100 atmospheres and at temperatures from 0° C. to 100° C., the relative differences between the experimental result and that calculated from the above equation do not exceed 0·6 per cent.—Hector **Pécheux**: The magnetism of nickel. Magnetic measurements are given for three samples of nickel (the analyses of which are given) without heat treatment, after tempering and after annealing.—Nicolas **Perrakis**: Contribution to the cryoscopic study of binary organic mixtures. An account of a cryoscopic study of the systems phenol-ethyl alcohol, *o*-cresol-ethyl alcohol, phenyl ether-ethyl alcohol, benzene-methyl alcohol, benzene-isopropyl alcohol, and benzene-normal-butyl alcohol.—E. **Darmois**: The action of molybdic acid on the rotatory power of the tartaric and malic esters. An account of the changes in rotatory power produced by the action of aqueous solutions of molybdic acid and alkaline molybdates on methyl tartrate and ethyl malate.—Victor **Henri**: The production of narrow bands and wide bands in the absorption spectra of bodies in solution and in the state of vapour. A study of the conditions under which a modification of the structure of an organic substance causes the change from a line absorption spectrum to a band spectrum. For molecules containing only one double linkage, the first postulate of Bohr does not apply and the second postulate alone holds; for molecules with two neighbouring double bonds, both postulates apply, the first being determined by the existence of an electric polarity in the molecule.—M. **Sauvageot** and H. **Delmas**: Tempering extra soft steel at a very high temperature. A mild steel containing 0·09 per cent. of carbon was tempered in water, starting with temperatures from 950° C.

up to 1450° C. There was a rapid increase in the elastic limit, resistance and hardness, as the temperature rose.—E. E. **Blaise**: Syntheses by means of the mixed α-ketone zinc derivatives.—Marcel **Godchot**: The oxidation of 1.3.4-dimethylcyclohexanone and the synthesis of cyclopentane diketones. The oxidation of the above ketone with potassium permanganate gives a good yield of γ-methyl-δ-acetyl-valeric acid. The ethyl ester of this acid, treated with powdered sodium ethylate in ether solution gives α-acetyl-β-methylcyclopentanone. The latter, being a β-diketone, forms a sodium derivative capable of reacting with alkyl iodides.—Raymond **Delaby**: The action of mixed organomagnesium compounds on the epibromhydrin of ethylglycerol.—M. **Caille** and E. **Viel**: A new reagent for alkaloids and the preparation of the iodostibinates of these substances in the crystallised state. The reagent consists of a slightly acid solution of antimony chloride with potassium iodide. One part of quinine in 100,000 can be detected; it forms a yellow precipitate. The method appears to be equally sensitive with other alkaloids. By a suitable treatment the alkaloid can be recovered from the precipitate unchanged.—A. **Mailhe**: The decomposition of the formamides of the fatty amines. Isoamylformamide vapour, passed over nickel at 360° C. gives a mixture of isoamylamine and isoamyl nitrile.—M. E. **Denaeyer**: The rocks of Adrar des Iforass and Ahaggar. Two salient facts are shown by the study of the rocks from the central Sahara, their crushing, related to the existence of the Saharan folds, and the existence of alkaline amphibole granites. These rocks mark a new extension towards the west of the limits of the alkaline petrographical province of the Tchad.—E. **Chaput** and L. **Perriaux**: The existence of Albian sands and calcareous pudding stones on the high plateaux of the Côte-d'Or.—Léon **Bertrand**: The Provençal sheets to the east of the lower valley of the Var.—L. **Barrabé**: The transported origin of the Lias massif situated to the west of Narbonne.—Paul **Corbin** and Nicolas **Oulianoff**: The Mesozoic of Prarion (Arve valley).—A. **Allemand-Martin**: The Pliocene of the Cap Bon peninsula (Tunis).—Henri **Coupin**: The morphological nature of the head of the cauliflower. The head of the cauliflower is not formed by flowers, but by stems arrested in their development. This arrest is of tetratological, not parasitic, origin.—R. **Chavastelon**: A method for the preservation of wood. A solution of copper bichromate is recommended and instructions for its preparation are given. Wood thus treated is very resistant to the attack of moulds.—Fred **Vlès**, Mlle. G. **Achard**, and Dj. **Prikelmaier**: Some physico-chemical properties of the constituents of the egg of the sea urchin.—E. **Leblanc**: Experimental acerebellation in lizards.—J. **Gautrelet**: Shock and parasympathetic reactions.—A. **Policard**: The histochemical detection of total iron in tissues by the method of incineration. The section is ashed and the iron detected by the colour of its oxide under the microscope.—C. **Levaditi** and S. **Nicolau**: The mode of action of bismuth in trypanosomiasis and spirillosis.

Official Publications Received.

U.S. Department of Agriculture. Department Circular 187: List of Serials currently received in the Library of the U.S. Department of Agriculture; exclusive of the U.S. Government Publications and Publications of the State Agricultural Colleges and Experiment Stations. Arranged by Title, by Subject, and by Region. January 1, 1922. Pp. iii+358. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin No. 6: State Policies in Public School Finance. By F. H. Swift. Pp. iv+54. 10 cents. Bulletin No. 15: A Kindergarten First-Grade Curriculum. By a Sub-Committee of the Bureau of Education Committee of the International Kindergarten Union. Pp. vii+66. 10 cents. Bulletin No. 23: High-School Buildings and Grounds: a Report of the Commission on the Reorganization of Secondary Education, appointed by the National Education Association. Pp. xi+49. 15 cents. Bulletin No. 26: Philanthropy in the History of American Higher Education. By J. B. Sears. Pp. vi+112. 15 cents. Bulletin No 29: Statistics of State School Systems, 1919-20. Prepared by Florence Du Bois and H. R. Bonner. Pp. 68. 10 cents. Bulletin No. 30: Accredited Higher Institutions. By G. F. Znok. Pp. vii+106. 15 cents. Bulletin No. 34: Statistics of Land-grant Colleges, Year ended June 30, 1921. By L. E. Blauch. Pp. iii+67. 10 cents. (Washington: Government Printing Office.)

The Record of the Royal Institution of Great Britain, 1922. Pp 122. (London: Royal Institution.)

Year-Book of the Department of Agriculture, Ceylon, 1923. Pp 64+41 plates. (Colombo: H. W. Cave and Co.)

Statens Meteorologisk-Hydrografiska Anatalt. Årsbok 4, 1922. 1: Månadsöversikt över väderlek och vattentillgång. Pp. 139. (Stockholm.) 2.50 Kr.

The Kent Incorporated Society for Promoting Experiments in Horticulture. Annual Report, together with Notes upon the first Ten Years' Work, East Malling Research Station, 1st January 1922 to 31st December 1922 Pp. 52. (East Malling.) 1s.

Diary of Societies.

SATURDAY, May 19.

Royal Institution of Great Britain, at 3.—J. B. McEwen: Harmonic Evolution.

TUESDAY, May 22.

Royal Institution of Great Britain, at 3.—Prof. W. M. Flinders Petrie: Discoveries in Egypt (1).

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—A. J. Bull: The Relation of Selective Absorption of Printing Colours to the Errors occurring in Three-Colour Photography.

WEDNESDAY, May 23.

Royal Microscopical Society, at 7.30.—Annual Pond Life Exhibition.

THURSDAY, May 24.

Medico-Psychological Association of Great Britain and Ireland (at Royal Society of Medicine), at 3.—Dr. C. K. Clarke: The Fourth Maudsley Lecture.

Royal Institution of Great Britain, at 3.—Prof. E. G. Coker: Engineering Problems Solved by Photo-elastic Methods (2). The Testing of Materials; The Action of Cutting Tools.

Linnean Society of London, at 5.—Anniversary Meeting. Presentation of the Linnean Gold Medal to the High Commissioner of New Zealand for transmission to T. F. Cheeseman.

Optical Society (at Imperial College of Science and Technology), at 7.30.—D. Baxandall: Telescopes from a Historical Standpoint. (Illustrated by exhibits from the collection in the Science Museum, South Kensington.)

FRIDAY, May 25.

Royal Society of Medicine (Study of Disease in Children Section) (Annual General Meeting), at 5.—Discussion on Birth Injuries.

Physical Society of London (at Imperial College of Science and Technology), at 5.—Prof. C. H. Lees and J. E. Calthrop: The Effect of Torsion on the Thermal and Electrical Conductivities of Metals.—A. Rosen: The Use of the Wien Bridge for the Measurement of Dielectric Losses.—C. R. Darling: Demonstration of an Experiment on the Production of an Intermittent Pressure by Boiling Water.—Dr. N. W. McLachlan: Demonstration of a Novel Instrument for recording Wireless Signals.

Royal Society of Medicine (Epidemiology and State Medicine Section) (Annual General Meeting), at 8.—Prof. E. L. Collis: An Inquiry into the Mortality of Coal and Metalliferous Miners in England and Wales.

Royal Institution of Great Britain, at 9.—Sir Aston Webb: The Development of London.

SATURDAY, May 26.

Royal Institution of Great Britain, at 3.—J. B. McEwen: Musical Education.

PUBLIC LECTURES.

TUESDAY, May 22.

Gresham College, at 6.—Sir Robert Armstrong-Jones: Physic (succeeding Lectures on May 23, 24, and 25).

THURSDAY, May 24.

St. Mary's Hospital (Institute of Pathology and Research), at 4.30.—Dr. B. Hart: The Development of Psychopathology as a Branch of Medicine.

Royal Society of Medicine (Robert Barnes Hall), at 5.15.—Prof. E. D. Wiersma: The Psychology of Epilepsy.

FRIDAY, May 25.

University College, at 5.—Prof. C. Spearman: Psychology as a Career.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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The Pasteur Institute.

FRANCE is occupied this week with the celebration of the centenary of Pasteur's birth. We, in Great Britain, have made but a poor thing of the occasion. It is true that we have praised Pasteur, and published our recognition of his work; but there has been nothing to show that he takes a foremost place in our national imagination. That is the worst of being an island. We are very proud of Shakespeare, but we are slow to admit foreigners into his company; yet our national gratitude toward Pasteur, so far as it is possible to compare men so unlike, ought to be even more certain than our gratitude toward Shakespeare. It is strange and disgraceful that we have not yet set up a monument to Pasteur in London. Indeed, we have not even inscribed his name on any building to remind everybody of our national debt to him.

Things have been done better in France. It is possible that the worship of Pasteur has gone too far, in the "filming" of him. This film was exhibited at the Jubilee meeting at the Sorbonne, on December 27 last. There are really three films: one to popularise some scenes of Pasteur's life, and two for the more exact teaching of schools and institutes. *L'Illustration* for March 31 gives a delightful account, with many pictures, of these films. Doubtless we shall see them in England. Meanwhile, some of us have seen Pasteur "staged," and admirably acted by M. Guitry.

Men and women of science may or may not stand the test of acting; but they are not intended for "filming." Take some names at random—Newton, Darwin, Lister, Kelvin: films "featuring" them would be nightmares. Besides, the whole meaning and beauty of their work would be left out. Their work began in them, but did not stop there; it became the work of their followers; it took many shapes, and was extended into many new fields of thought and of action. So with Pasteur's work: he founded his kingdom in every country of the world; his influences are everywhere; and that saying of his, in the last year of his life, "Tant de choses encore à travailler," stands for the immeasurable extension of his kingdom.

We have received Dr. Calmette's report, "L'œuvre de l'Institut Pasteur pendant la guerre." This valuable report is published by the Association "pour l'extension des études pastoriennes." An English translation has been issued. The immediate purpose of this Association, which was formed in 1922, is to collect funds to help students to work on the lines which Pasteur laid down. Twenty-six members of the Pasteur Institute died on active service during the war. The cost of living is a great difficulty in the way of students who are longing for good work. The Association proposes to enrol members, whose subscriptions shall provide scholarships and endowments of research. We cannot think of a better way of using these funds. We are asked also to say that the Association has a store of bronze medals, commemorative of Pasteur, which may be obtained for 5½ francs from the Secretary, 6 rue de Messine, Paris.

Dr. Calmette's report of the work of the Institute during the War is well worth reading. He rightly makes much of the fact that the work of the Pasteur Institute was incessant and far-reaching in the years just after Pasteur's death. "In less than a third of a century, Pasteur's teachings revolutionised medicine, surgery, veterinary science; created entirely the science of hygiene for individuals and communities; gave a great impetus to colonisation, and enriched nations by the immense progress of agriculture and agricultural industries."

The War suddenly strained all the energies of the Pasteur Institute. All those workers who were not above the age for active service were mobilised. The Institute, and its branches in Lille and Algiers, were requisitioned at once for the needs of the Army. The demand for protection against typhoid was soon followed by the demand for protection against tetanus. It took only a few days to use up the antitetanic serum—140,000 doses—which was in stock when the War began. Between August 1914 and the end of 1914 the Institute was able to provide more than six million doses of sera for France alone, partly for the Army, and partly for the Public Health service. During the German offensive of March-April 1918, the Institute was providing a vast daily supply of antitetanic serum. It is worth noting that the Institute also provided, in the course of the War, as many as 1,200,000 doses of mallein for the protection of army horses against glanders. Beside all the work which was done for the Army in France, we have to take into account a vast amount of work done for other countries—Italy, Serbia, Rumania, Belgium.

Moreover, there was all the endless business of research and invention to meet the incessantly changing conditions forced on the Institute by the exigencies of war. For example, an immense amount of work was done on poison gases.

Indeed, the whole strength of the Institute was put forth unsparingly, not only for the Army but also for the civilian population. Dr. Calmette does well to praise the branch Institute in Lille. "Though it was paralysed, we may even say martyrised, by the German occupation so early as the first part of October 1914, it took its share in the common work. Our colleagues who lived there four years, immured, without any sort of communication with France, without a letter, without any journals except the political newspapers of Cologne or Frankfort, deprived of almost every means of work, with much of their material destroyed or stolen, did all that was possible with their authority and zeal to protect the civil population against the moral and material miseries of all sorts from which they suffered."

Of course, other countries were not less busy than France. They were all working on Pasteur's lines. It was he, and he alone, who inspired them. To him the Franco-German War of 1870 had brought misery; he took it as his revenge to set France, by his work, high above Germany. There are not many of us now living who can boast that we met Pasteur here in England, and shook hands with him, and heard him talk of his work. One of us had this good fortune; and remembers well the grave and unhappy look of his face, and the measured and serious tone of his voice. It was given more to his family and his friends to know something of the wonderful beauty of his life. The pity is that we in England have no memorial of him; nothing to express to France our gratitude for what he did for us.

Hormones.

Glands in Health and Disease. By Dr. Benjamin Harrow. Pp. xvi+218. (London: George Routledge and Sons, Ltd., 1922.) 8*s*. 6*d*. net.

THERE is probably no chapter in physiology which calls forth to such an extent our sense of the marvellous as that dealing with the internal secretions and the functions of the ductless glands. All the effects which have been ascribed in the imagination of mankind to the action of beneficent or maleficent fairies or deities are brought here within the domain of sober physiology as possible results of deficiency or excess of one or other of the internal secretions. The production of dwarfs and giants, change of personality, mania, dementia, and idiocy, the manifestations of love, hate, rage, and fear, the characteristics which distinguish male from female, the powers of reproduction and all associated therewith, the normal performance of the processes of digestion and metabolism, have all been shown to be bound up with the power of certain cells in the body to manufacture chemical substances which they pass into the bloodstream. It seems quite natural that the respiratory centre should be stimulated to greater activity by the increased production of carbonic acid which accompanies muscular exercise, so providing the working muscles with a sufficiency of oxygen for their needs. A further development of this correlation by chemical messengers is found in the alimentary canal, where the presence of the products of digestion in the stomach excites, by means of a hormone, the further secretion of gastric juice. In the same way the entry of the acid products of gastric digestion into the small intestine evokes in the epithelial cells lining this tube the development of a substance—secretin—which is absorbed by the blood-vessels and carried round to the pancreas, liver, and intestinal glands, so as to bring about the simultaneous secretion of the three juices the co-operation of which is necessary for the complete digestion of all classes of foodstuffs.

These are examples of the restricted action of the chemical messengers, resembling closely the reactions brought about through the intermediation of the central nervous system, so that we are justified in speaking of them as chemical reflexes. Other hormones have a much wider action, which may extend to all or almost all the cells of the body. Our knowledge of these is scarcely half a century old, and began with the discovery in England of the relation of myxœdema and cretinism to atrophy or failure in development of the thyroid gland. Later research has shown that these conditions are due to the absence of a secretion manufactured by the thyroid. This secretion has been isolated and has been found to be a substituted iodine derivative of tryptophane. On its constant presence in the blood depends the normal growth and metabolism of all the tissues of the body. Since these include the central nervous system, development of the mind is affected as well as that of the body. Absence of this secretion in early life results in the production of a stunted cretin. Increased secretion by a hypertrophied gland causes increased rate of metabolism, quickened heart-beat, excitability which may culminate in mania, changed personality—all of which may disappear when the gland diminishes in size or the hypertrophied portion is removed.

Still more wonderful and widespread in its effects is the pituitary body. This consists of two parts—one of which is derived from the brain, the other from the back part of the buccal mucous membrane of the fœtus; each part is only about the size of a pea. Increased activity of the anterior part gives rise to gigantism in the growing animal, or, when it affects the adult, the overgrowth and deformation of face, hands, and feet, which is known as acromegaly. If it were possible to isolate and administer the chemical substance responsible for these growth changes, we should be able to rival the effects of the "Food of the Gods" imagined by Mr. H. G. Wells. Atrophy of this part causes diminished growth, excessive fat production, and a condition of infantilism, with lack of development of the sexual functions. The posterior part, which in appearance seems to consist of little else but neuroglia, the supporting tissue of the central nervous system, produces some substance which can be extracted from it by boiling water, and has, in infinitesimal doses, widespread effects on the most diverse tissues of the body. This extract is sold under the name of "pituitrin." According to the conditions existing at the time of administration it may increase or diminish the flow of urine; it causes rise of blood-pressure and contraction of the uterus, as well as of all other unstriped muscle, such as that of the intestines. For these purposes it has come into actual practice as a therapeutic agent. Its presence in minute quantities in the blood seems to be a necessary condition for the contractility of the blood capillaries, so that it becomes a regulator of the supply of the nutrient blood to all the tissues of the body.

It is not surprising that these later achievements of physiological research have impressed public opinion and have had a marked effect in the United States, where the public interest in things medical is aroused every week by popular articles on medical science in the Sunday papers. The arousing of uneducated curiosity has its dangers as well as its value. Sensationalism and imagination have not only rushed ahead of the ascertained facts but have also opened the way to a shameless exploitation of the uneducated curiosity which has been aroused. It is not so many years since bits of animal organs were regarded as essential ingredients of remedies for disease as well as for love-philtres and charms. The heart of the tiger or of the brave enemy was eaten to give courage to the victors, and at the present day we find a therapeutics advertised and exploited which is nothing less than a return to the superstitious practices of the middle ages. The principle is simple. If the kidney is affected, dried kidneys of animals are administered; if there is a failure of sexual powers, ovaries or testes are administered in the same way. It is only necessary to locate the disorder in order at once to apply the appropriate remedy. Charlatanism finds an easy and profitable prey in the curious and uneducated. The only protection against its attacks lies in more complete education, and it is for this purpose that such a book as that of Dr. Benjamin Harrow is useful. The author is apparently not a medical man, but is an associate in physiological chemistry of Columbia University. Though the restriction of his knowledge and experience is apparent, the book is nevertheless of value as a dispassionate and objective statement of the facts which are so far known as to the internal secretions. Throughout the author maintains a proper sceptical attitude in face of the uncritical or prejudiced statements which have been put forward by clinicians as to the influence of various preparations of the organs involved.

There are a few errors of fact, as well as certain questionable conclusions, which might well be omitted in future editions. The statement that the action of these hormones is catalytic is unjustified and means nothing. We cannot speak of catalysis—*i.e.* a hastening of a chemical action—unless we have some definite chemical action in mind. In the case of these hormones, as in the case of drugs such as alkaloids, we have not the remotest idea how they work. It may be that their action is by catalysis of one or other of the reactions which occur in the series making up the life of the cell, but there is no evidence for or against such a statement, and there is a distinct danger that, by putting the action of drugs or hormones into such a category, we may forget our ignorance and refrain from further attempts at an analysis of the manner in which they work.

The author seems unaware of the fact so clearly brought out by Pézard, that the plumage of the cock is that of the neutral animal, desexualisation of the hen bringing about the production of the cock's plumage, which is left unaffected in the male by removal of the testes. It is not correct to speak of enterokinase as a hormone; it is a ferment which has a definite action on the trypsinogen secreted by the pancreas, converting this into trypsin. Two statements are a little surprising. In explanation of the term "thyroidectomy" it is mentioned that "dectomy" equals excision. Later on in the book the word "secretin" is stated to be derived from the Greek "to excite." These, however, are minor flaws and do not interfere with the value of the book as a whole, which can be recommended as an interesting and well-balanced account of the present condition of our knowledge on the subject of internal secretions. It is couched in such language that it will be intelligible to any educated reader with the veriest smattering of scientific knowledge.

E. H. S.

Modern Processes of Ore-Dressing.

A Text-Book of Ore-Dressing. By Prof. S. J. Truscott. Pp. xi+680. (London: Macmillan and Co., Ltd., 1923.) 40*s*. net.

IN his preface Prof. Truscott states that his work is written primarily for the service of his own students at the Royal School of Mines, and correctly observes that such a book is needed owing to the important development of flotation processes in recent years.

From the dedication—"To Almighty God, the father of our Lord Jesus Christ"—one must infer that the author has put forth his best efforts into the work, and it certainly does bear evidence throughout of painstaking care. The matter is arranged methodically; the drawings and diagrams are abundant and excellent, and their selection leaves little to be desired. The many non-essential details which are often found in descriptions of ore-dressing plants do not occur, and all the space is well employed to give the student a correct and easy understanding of the subjects described.

The book deals first with washing and sorting methods and appliances, then with the various types of machines for breaking, crushing, and grinding of ores. Next are considered the problems and appliances for sizing by screens and by water, after which water concentration is described. The latter half of the book deals mainly with flotation concentration, magnetic, electrostatic, pneumatic, and centrifugal separations.

The space devoted to flotation (one-fifth of the total text) is indicative of the rapid growth and extreme practical importance of this method of concentration, which in less than twenty years has revolutionised the treatment of low-grade ores.

On the whole, the author is to be congratulated upon his presentation of a concise view of flotation technics to the general student, since the subject matter is extensive and in some aspects recondite. Under these conditions his treatment of the practical section must be considered satisfactory, but the chapter devoted to the more theoretical aspects of the subject is somewhat involved. This is scarcely to be wondered at, since a comprehensive theory of flotation (which at almost every point involves problems in regions of molecular physics only partially explored) has yet to gain general acceptance, and is still the battle-ground of two schools of thought—those on one hand who adopt the doctrines of the later school of colloid chemists, seeking explanations for causation based mainly on electrical theories, and the other or physical school, which finds sufficient explanation by the application of purely molecular laws. Electrical theories are both proximate, as the assumed electrical or electrostatic nature of flocculation and deflocculation phenomena, and ultimate, in seeking to explain the useful properties of oils and other reagents used in flotation in terms of the electronic constitution of atoms and molecules. The physical school is concerned only with the elucidation and quantification of the molecular attractive forces exerted between the reacting surfaces at liquid-solid contacts, such as give rise to surface- and interfacial-tensions, adsorption, and so on. On these grounds the phenomena of flocculation and deflocculation also seem to be more satisfactorily explained than by the electrical hypothesis.

Prof. Truscott, however, prefers to divide his favours between the two schools, accepting molecular attractions as explanatory of most of the flotation reactions, but adopting the electrical hypothesis for flocculation. The importance of the latter factor may be judged from the generalisation, now widely accepted, that where particles in an ore-pulp can be flocculated they can be floated; conversely, when they are put into the condition of deflocculation (suspension or peptisation are other terms used) flotation of such particles will be rendered impossible. A main object of flotation is, therefore, to flocculate the valuable mineral in a pulp, and to deflocculate the gangue or unwanted mineral.

It may be pointed out that Brownian motion (p. 510, para. 6) is not due to the "inherent kinetic energy of extremely fine particles": these indeed are passive agents, their motion being imparted by the kinetic energy of the water molecules which continuously bombard them—as shown in Perrin's classic experiments. Some other statements will provoke critical comment and seem to require qualifications—such, for example, as that on p. 506, where it is stated that the necessary filming of a mineral with oil cannot be achieved if the oil be completely emulsified. In the form stated it is not a fact, and theoretically it seems to overlook the phenomena of adsorption.

It should be mentioned that the book makes no serious attempt to deal with many of the problems which invariably confront the designers of mills, such as grades for launders and pipes, wet and dry pulp elevators and pumps, ore-bin construction, automatic feeders, etc. This, however, cannot be regarded as a shortcoming, and is perhaps to be commended, for the student should not be encouraged to imagine that he is fully competent to design a plant. It should be sufficient for him to obtain a thorough understanding of all ore-dressing appliances and methods in general use, and it is difficult to conceive how he could obtain so much sound knowledge so readily, and conveniently prepared for him, as he can in this book. Prof. Truscott apparently refrained from showing partiality towards any particular machines or methods, and has been cautious in his references to their merits or demerits. Practically everything said may be accepted as trustworthy, though a few statements noticed in respect of metallurgical matters are not strictly correct; for example, that much high-grade lead ore is smelted in reverberating furnaces, that zinc necessarily renders slags pasty, and that lead is highly objectionable in the retorting of zinc. These slight inaccuracies do not, however, affect the arguments they are used to illustrate.

S. J. S.

New Works on Relativity.

The Mathematical Theory of Relativity. By Prof. A. S. Eddington. Pp. ix+247. (Cambridge: At the University Press, 1923.) 20*s.* net.

The Principle of Relativity with Applications to Physical Science. By Prof. A. N. Whitehead. Pp. xii+190. (Cambridge: At the University Press, 1922.) 10*s.* 6*d.* net.

The Meaning of Relativity: Four Lectures delivered at Princeton University, May 1921. By Albert Einstein. Translated by Prof. Edwin Plimpton Adams. Pp. v+123. (London: Methuen and Co., Ltd., 1922.) 5*s.* net.

Modern Electrical Theory: Supplementary Chapters. By Dr. Norman R. Campbell. Chapter XVI.: Relativity. (Cambridge Physical Series.) Pp. viii+116. (Cambridge: At the University Press, 1923.) 7*s.* 6*d.* net.

La Théorie de la relativité d'Einstein et ses bases physiques: exposé élémentaire. Par Max Born. Traduit de l'allemand d'après la seconde édition par Dr. F.-A. Finkelstein et J.-G. Verdier. Pp. xi+339. (Paris: Gauthier-Villars et Cie, 1923.) 25 francs.

The General Principle of Relativity in its Philosophical and Historical Aspect. By Prof. H. Wildon Carr. Second edition, revised and enlarged. Pp. viii+200. (London: Macmillan and Co., Ltd., 1922.) 7*s.* 6*d.* net.

The Theory of General Relativity and Gravitation: Based on a Course of Lectures delivered at the Conference on Recent Advances in Physics held at the University of Toronto, in January 1921. By Dr. Ludwik Silberstein. Pp. vi+141. (Toronto: University of Toronto Press, 1922.) 2.50 dollars.

The Mathematical Theory of Relativity. By Prof. A. Kopff. Translated by Prof. H. Levy. Pp. viii+214. (London: Methuen and Co., Ltd., 1923.) 8*s.* 6*d.* net.

Vector Analysis and the Theory of Relativity. By Prof. Francis D. Murnaghan. Pp. x+125. (Baltimore: The Johns Hopkins Press, 1922.) n.p.

L'Évidence de la théorie d'Einstein. Par Prof. Paul Drumaux. Pp. 72. (Paris: J. Hermann, 1923.) 6 francs.

OF all the books on the Principle of Relativity which it has been our good and ill fortune to peruse during the last three years, there are none which have given such food for thought as those of Profs. Eddington and Whitehead. Other books, and their name is legion, fall into several well-defined classes. Among those before us are two serious and well-executed books addressed to students of experimental physics by Dr. Norman Campbell and Dr. Max Born. We are glad to note a cessation of the flood of popular accounts in which, mainly without success, more and less well-equipped writers have felt called upon to try their skill at hitting off the average man's understanding. Then there are the books in which metaphysicians have told us the effect which their reading around the subject, largely in semi-popular treatises, has had upon their thinking in regard to theology, sociology, and things in general. To this very important branch of the literature Prof. Wildon

Carr adds a new edition of his valuable book, which he has extended by a new chapter giving a more detailed description of Einstein's theory. Then there is a group of bare expositions of Einstein's theory, following closely his published work, with little digression or reflection. To this class belong the works of Drs. Silberstein and Kopff, which are mainly a record of lectures given by the authors in Toronto and Heidelberg respectively. Einstein's own volume, entitled "The Meaning of Relativity," is disappointing, as it falls straight into the same group, and gives us little more light on the *meaning* of relativity, save a re-emphasis that it is mainly a matter of mathematics. Prof. Murnaghan in his volume is more specially concerned with the pure mathematics, and seeks to lessen the difficulties of "The Absolute Differential Calculus" in any number of dimensions by tracing the whole subject through in an elementary manner. Prof. Drumaux writes a bright, readable, and well-balanced account of the theory; his general conclusions are admirable.

But the latest works of Profs. Eddington and Whitehead have characters of their own. We are exceedingly glad to have kept Prof. Whitehead's book by us until we have had an opportunity of seeing in book form the matured results of Prof. Eddington's mathematical investigations and his speculations as to the interpretation to be placed upon it all. We should recommend all those who are puzzled by the higher flights of his imagination to sit down to Prof. Whitehead's book, and after worrying through his first four chapters on physical principles to come back to Prof. Eddington and reconsider what he has to say. For while we yield to no one in our admiration for the work which the latter has done in emphasising the necessity for a thorough revision of the basic ideas of physical science, there remains an obstinate feeling that some of the more fascinating glimpses which he gives us may not stand a thorough logical examination. Prof. Whitehead, on the other hand, is a conservative. He acknowledges and presupposes the magnificent stroke of genius by which Einstein and Minkowski assimilated time and space, but, as he says, "The worst homage we can pay to genius is to accept uncritically formulations of truths which we owe to it."

Accordingly, the major part of his book is devoted to a logical consideration of the spatio-temporal character of events. Chapter II. consists of a lecture on "The Relatedness of Nature," given to the Royal Society of Edinburgh. It emphasises the fact that in our contemplation of Nature we are regarding events and processes. Descartes considered "stuff" (matter, ether) as being separable from the concept of process, realising itself at an instant, without duration; and to him "extension" was an abstract from the more concrete concept of "stuff." Space is thus essentially dissociated from time. But if, as Prof. Whitehead does, we find in events the ultimate repositories of the varied individualities in Nature, then we obtain the four-dimensional space-time as an abstract from those events. Space and time are thus correlative abstractions which can be made in different ways, each way representing a real property of Nature. The "event" or "point-event" which is made fundamental by many writers is therefore a pure abstraction, a fundamental element in the deductive and synthetic conceptual model which we have formed of Nature, holding the same place in it as the "point" in Euclid's elements of geometry.

So far we should find complete agreement between Einstein, Minkowski, Eddington, and Whitehead. It is when we come to the next chapter that we begin to feel that new ground is being broken, for Prof. Whitehead has perceived that the careful scrutiny of fundamental ideas necessitated by this unification of space and time has not yet been thoroughly carried out. The whole question of the nature of measurement and how it is at all possible has to be tackled, and we must begin by analysing the notion of "equality." In accordance with the ideas above, the fundamental step must be the matching, not of permanent bodies, but of passing events. "How time is to be got from the relations of permanent bodies completely puzzles me." "Why this pathetic trust in the yard measure and the clock?" he exclaims. So, starting from the simple idea of equality, we are led on into all those speculations concerning the character of the universe which have been raised by Einstein's theory.

We are left at the end of this chapter with a sense that "equality" and "measurement," far from being the sure foundation of physics, are either crude and primitive modes of experimentation or else the finishing touches to a wonderfully wrought conceptual picture of Nature. Here we think Prof. Whitehead and Prof. Eddington will be in sharp disagreement, and here we think remains still much room for clear exposition and hard thinking. While we welcome Prof. Eddington's authoritative exposition of the mathematical theory of relativity, our doubts as to the logic of his fascinating general account of the theory are confirmed. In the first section the fundamental hypothesis is stated that "everything we can know about a configuration of events is contained in a relation of extension between pairs of events. This relation is called the *interval*." The equality of intervals is to be tested observationally. We are told to take a configuration of events, namely, a measuring-scale, and lay it over a distance AB, and observe that A and B coincide with two particular events P, Q (scale-divisions). It seems to us that a scale-division is not an event at all, but a world-line or chain of events. We are then to do the same to a distance CD, and so prove the equality of the distances AB and CD. We are told that in this experiment time is not involved, and to conclude that in space apart from time the test of equality of distance is equality of interval. Yet the essence of a measuring-scale is its permanence in time. We stumble badly over these opening paragraphs, and are glad to get on to the mathematical developments where all goes smoothly.

The same confusion of thought, as it seems to us, occurs again in the interpretation of Einstein's law of gravitation which is Prof. Eddington's own (§ 66). Einstein's law is equivalent to the statement that the radius of spherical curvature of the three-dimensional section of the world at right angles to any direction in the four-dimensional continuum has the same constant length $\sqrt{(3/\lambda)}$. A "more precise statement of this result" is said to be that "the radius of curvature of the world at any point and in any direction is in constant proportion to the length of a specified material unit placed at the same point and orientated in the same direction." In this more precise statement the word direction is used in the first instance for a direction in the four-dimensional world, but "the length of a specified material unit placed at the same point and orientated in the same direction" can only be interpreted as referring to three dimensions.

We do not raise these criticisms in any captious spirit. We believe there is a great deal to be said in favour of the general point of view stressed by Prof. Eddington that the uniformities revealed in Nature by physical experiment would not have been found if our physical measurements had not been made with apparatus which is itself part of Nature and is therefore pervaded by the universal relations. But the picturesque and concise language employed from time to time in this book may only too easily persuade the reader that he has understood when he has in reality only shirked the issue.

Thus, after thanking the author for his very complete account of the existing state of the theory and its speculative developments, we return almost gladly to Prof. Whitehead's conservatism, and read his chapter on some "Principles of Physical Science." We are almost grateful for his old-fashioned belief in the fundamental character of simultaneity, adapted to the novel outlook by the qualification that the meaning of simultaneity may be different in different individual experiences. We admire his cautious tread along these unexplored paths, and we should welcome him as our critic in the task that urgently needs undertaking, of examining the precise position to be allotted to the notion of "measurement" in the conceptual universe of the relativist.

Fossil Mammals from Bolivia.

Mammifères fossiles de Tarija. Par Prof. M. Boule, avec la collaboration d'A. Thevenin. (Mission scientifique G. de Créqui-Montfort et E. Sénéchal de la Grange.) Pp. vii + 255 + 27 planches. (Paris: H. Le Soudier, 1920.)

FOR more than three hundred years a great accumulation of bones has been known in the highlands of Bolivia near the small town of Tarija. The bones are scattered in confusion through a deposit of sandy mud, the parts of a skeleton rarely in natural association; and they are often well exposed in the little ravines which mountain torrents and streams have cut through the deposit in all directions. During the final years of the last century a large collection of the specimens was made by some local residents, Messrs. Echazù, and when the Marquis de Créqui-Montfort was exploring the country in 1903 he purchased this collection, and eventually gave it to the National Museum of Natural History in Paris. The Marquis has now generously provided the means for the publication of the handsome volume before us, in which Prof. Boule, assisted partly by the late M. Thevenin, makes the new discoveries available for science. The work is dated 1920, but was only distributed last year.

All the bones in the deposit at Tarija belong to mammals, most of them large, closely resembling those found in the sand and mud of the pampa of Argentina and in the caves of Brazil. They date back either to the latter part of the Pliocene or to the early part of the Pleistocene period, and are therefore of special interest, because they represent the time when the mastodons, tapirs, horses, llamas, deer, peccaries, and higher carnivores had just come south from the northern hemisphere over the newly-emerged land of central America, and had mingled with the strange edentates, rodents, toxodonts, and macrauchenias which were indigenous to South America, and soon became, for the most part, exterminated in their rivalry with the invaders. Altogether, thirty-five species of large size are represented, and their remains are described in detail by Prof. Boule, with the aid both of beautiful plates in photogravure and of numerous effective text-figures.

The individuals of several species are rather small compared with the corresponding forms found in the Argentine pampa and other favoured regions, for Tarija is at present nearly 2000 metres above the sea, and even at the beginning of the Pleistocene period, when the elevation was possibly less, the conditions cannot have been very genial. When the assemblage of animals in question was living in that country, however, there must have been both greater warmth and more moisture to provide sufficient vegetation. The mastodons, tapirs, and perhaps macrauchenias, must have inhabited damp forests on the edge of swamps. The giant ground-sloths, Megatherium and Mylodon, could scarcely exist without forest vegetation. The numerous and varied small horses and llamas were as usual adapted for life on grassy plains. The Glyptodon was also probably a feeder on grass, and the Toxodon, which may have fed on dry scrub, seems to have been comparatively rare. When conditions began to approach those now met with at Tarija, all these animals would be either exterminated or driven to lower regions.

Like all his other descriptive works, Prof. Boule's account of the mammalian remains from Tarija is much more than a technical treatise. It summarises and briefly discusses our knowledge of the evolution of most of the groups represented. It teems with facts and suggestions which will interest both zoologists and geologists. It is a most valuable contribution to palæontological science. A. S. W.

Our Bookshelf.

The Journal of the Institute of Metals. Edited by G. Shaw Scott. Vol. 28. Pp. ix+1010. (London: The Institute of Metals, 1922.) 31*s*. 6*d*. net.

THE new volume of the Journal of this Institute is very bulky, owing to an increase in the number of pages occupied by papers and also in that of the abstracts. Two general lectures are included, one being by Sir Ernest Rutherford on the relation of the elements, and the other by Dr. Hutton on motion study and vocational training, the latter subject being a new one in this connexion. The sixth report to the Corrosion Committee is mainly concerned with the influence of colloidal corrosion products on the process, and contains much interesting matter, although the theory remains in a very imperfect state. The authors do not commit themselves to the support of any of the theories proposed in this field, and consider that several different processes are possible. A further contribution to the subject of the age-hardening of the light aluminium alloys is made by members of the staff of the National Physical Laboratory, and the hypothesis originally proposed to account for ageing is confirmed by the newer work. Several other papers deal with the properties of aluminium and its alloys. A curious binary system is that studied by Mr. M. Cook. The alloys of antimony and bismuth form a continuous series of solid solutions when allowed to solidify slowly, but if, by rapid cooling, a heterogeneous structure is obtained, prolonged annealing does not lead to diffusion. This paper contains some excellent photo-micrographs. Other papers include a general survey of eutectics by Mr. F. L. Brady, and a method of deriving a value for the absolute hardness of metals from the Brinell test by Mr. F. W. Harris, as well as several contributions on technical matters.

The abstracts section shows a great increase in bulk, and the literature of metallurgy has evidently been searched very thoroughly; but some space might be saved by the avoidance of duplication, and by omitting papers which are merely popular summaries of existing knowledge, containing nothing new. It is always difficult to decide where the line should be drawn in such cases, but the fact that the present volume extends to more than 1000 pages proves that discretion is desirable in the admission of abstracts to this important Journal.

The Gold-Headed Cane. By Dr. William Macmichael. A new edition, with an Introduction and Annotations by George C. Peachey. Pp. xxiii+195+5 plates. (London: Henry Kimpton, 1923.) 18*s*. net.

WE recently directed attention to an edition of the "Gold-Headed Cane" edited by Dr. F. R. Packard of Philadelphia (see NATURE, March 3, p. 281). The present volume, which represents the fifth edition of the work, is edited by Dr. George C. Peachey, who is well known in the medical world as the historian of St. George's Hospital and as a writer of various articles of medico-historical interest. In a scholarly introduction Dr. Peachey points out that the only two discoveries of real value which had issued from English thought before the Restoration were the work of physicians, namely, the discovery of terrestrial magnetism by Gilbert in 1603 and the demonstration of the circulation of the blood by Harvey in 1628. In the later period, however, and notably with the death of Sydenham in 1689, the year in which the autobiography of the "Gold-Headed Cane" begins, the leading physicians of the period whose lives are related by the Cane were remarkable for their success in practice rather than for any important additions they made to knowledge. No important contributions were made to medical literature by Radcliffe, Mead, Askew, or Pitcairn. An exception, however, must be made in favour of Matthew Baillie, whose position in the history of medicine as the first great English pathologist is not mentioned by Dr. Peachey.

The present edition, which is more sumptuous than any of its predecessors, contains in addition to the original illustrations six fine photogravure portraits of Radcliffe, Mead, Askew, the Pitcairns, and Baillie.

Everyday Life in the New Stone, Bronze, and Early Iron Ages. Written and Illustrated by Marjorie and C. H. B. Quennell. (The Everyday Life Series, II.) Pp. x+119. (London: B. T. Batsford, Ltd., n.d.) 5*s*. net.

MR. AND MRS. QUENNELL must have found their little review of the Neolithic and succeeding Ages vastly more difficult to write than their earlier book on the Old Stone Age. Not only is the material more heterogeneous in character and more widely scattered, but on many points with which they have had to deal summarily there is also a lack of agreement among archæologists. The limitations of space and the requirements of their public have precluded any discussion of controversial matters. To bear this in mind is to disarm criticism on points which, in a more ambitious undertaking, might call for extended discussion.

Notwithstanding the vast amount of ground which has been covered and the mass of material which they have had to bring within the compass of their little book, the authors have produced an excellent and very readable popular account of the peoples of the later prehistoric ages in North-Western Europe and, in particular, of Britain. Without entering into detailed criticism, it may be suggested that more stress might have been laid upon early trade connexions between Britain and the Baltic and their bearing upon the archæological and ethnological problem. The synoptic chronological chart of ancient civilisations in parallel columns will be invaluable to those who have not made a special study of prehistoric archæology.

Der fossile Mensch. Von E. Werth. Zweiter Teil. Pp. 337–576. (Berlin: Gebrüder Borntraeger, n.d.) 12*s.* 8*d.*

This is the second part of a comprehensive treatise on the handiwork of early man. It begins with the middle of a sentence on p. 337 and ends in a similar way on p. 576, and the reviewer has not seen what went before or came after these broken sentences. The volume consists of a very detailed and exceptionally well-illustrated account of palæolithic flint implements, and gives information relating to the extinct fossil animals and plants associated with the various types of implements and to the problems of the glacial periods.

Throughout the book very full bibliographical references are given to memoirs written in the German language, and occasionally to those written in French; but works written in English and information which can only be obtained at first hand in English memoirs, such, for example, as that relating to the discoveries at Piltdown and elsewhere in Britain, are wholly ignored. Moreover, the views expressed in the book are strictly orthodox, and the author is very cautious in referring to matters which do not fall into the old scheme of interpretation adopted by him.

Although the work is called "Der fossile Mensch," there is, at any rate in this part, no reference to the fossilised remains of man. The book is a valuable work of reference for flint implements and for German ideas regarding problems of chronology. The author refers Pithecanthropus to the oldest interglacial period and assigns the Cromer Forest-bed to the same horizon.

G. Elliot Smith.

The Andover District: an Account of Sheet 283 of the One-inch Ordnance Map (Small Sheet Series). By O. G. S. Crawford. (Oxford Geographical Studies.) Pp. 99. (Oxford: Clarendon Press; London: Oxford University Press, 1922.) 7*s.* 6*d.* net.

Mr. Crawford's memoir covers an area which, as he points out, is not particularly well adapted to treatment on the lines of natural regions. In the main he contents himself with indicating the larger divisions, and has taken his units chiefly on a geological basis. On these lines he divides the area into three main natural regions—Andover, the belt of high ground between Basingstoke and Savernake, which is crossed by the Winchester and Newbury Road, and the Vale of Kingsclere. In addition, a portion of the London Tertiary basin and of the Vale of Pewsey come into the north-east and north-west corners respectively. Each of these is studied in detail in respect of its physical and economic aspects. In the latter section Mr. Crawford deals with a subject which in part he has made peculiarly his own, and his analysis of the relations of prehistoric Roman and modern settlements and of early and recent lines of communication in this area will be highly appreciated by archæologists and students of topography.

A number of useful appendices deal with such subjects as measurements, grouping of parishes, prehistoric sites, Anglo-Saxon bounds, forest regions, place-names, and the like. The volume is well illustrated by photographs and numerous plans prepared from the Ordnance Map.

Air Ministry: Meteorological Office. The Marine Observer's Handbook. Third edition (with corrections to September, 1922). (M.O. 218.) Pp. iv + 99. (London: H.M. Stationery Office, 1922.) 5*s.* net.

This book is prepared exclusively for the use of navigators and seamen who keep a record of the weather; it is especially intended for the mercantile marine. There are many essentials in the keeping of the Meteorological Log for the Meteorological Office, among which may be mentioned the uniformity of scales, much of which is new to the ordinary navigator. Instruments, if required, are loaned by the Meteorological Office, which in return for the instruments supplied claims possession of the Meteorological Log. Among the observations required are wind direction and force, barometer, temperature of air and sea, cloud, weather, state of sea, the set and rate of current, and other features of interest. The handbook shows how the observations should be made, and how the results are used for the advantage of seamen and others.

The present-day navigator has many advantages quite unknown to navigators in bygone days, especially with respect to wireless reports, which enable any captain afloat to make for himself by the aid of messages from other adjacent vessels a synchronous chart showing the weather conditions by which he is surrounded. Storms may thus be avoided, and advantage can be taken of favourable weather conditions.

C. H.

Cours de chimie inorganique. Par Prof. Fréd. Swarts. Troisième édition, revue et augmentée. Pp. iv + 734. (Bruxelles: M. Lamertin, 1922.) 50 francs.

The third edition of Prof. F. Swarts' "Cours de chimie inorganique" includes new matter dealing with the constitution of the atom, isotopes, and catalysis. It is perhaps the best book of its type that has appeared in French, but English students would probably prefer to learn chemistry from text-books of similar scope published in their own language.

Outlines of Theoretical Chemistry. By Prof. Frederick H. Getman. Third edition, thoroughly revised and enlarged. Pp. xi + 625. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 18*s.* 6*d.* net.

Prof. Getman's "Outlines of Theoretical Chemistry," which appeared just before the War, received a drastic revision in 1918. The third edition has been brought up-to-date by the inclusion of recent work on isotopes and on atomic structure, but retains most of the features of the preceding edition.

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.*]

Gravitation and Light-Pressure in Spiral Nebulæ.

PROF. LINDEMANN'S idea that the spiral nebulæ may be clouds of particles small enough to be repelled by light is of considerable interest. But we must remember that light carries with it another potential influence which it exerts when it encounters matter, namely, the power of ejecting an electron with an energy of the same order as that of the electron responsible for the light. Star-light, therefore, should be able to eject electrons with enormous energy; and this kind of induced radio-activity may have several partly unforeseen results. A stellar variety of spectrum is one of them, if a continuous spectrum can be composed of a multitude of fine lines, with gaps only where the specific exciting radiation was absent.

Unpolarised self-luminosity is surely more likely than mere reflection of incident light. The reddened light from the centre, observed by Mr. Reynolds, might well be a sunset effect, due to vision through a number of small blue-reflecting particles; the phenomenon does not harmonise so well with the idea of borrowed light.

I suppose that Dr. Jeans's spiral polar arms might occur in a Lindemann cloud as in any other enormous quasi-gaseous mass.

The fact that some few of these nebulæ are approaching the galaxy, instead of rapidly receding, may be accounted for by the suggestion that in these few the particles have aggregated into larger groups (as they may under some kinds of electrification), so that gravitation once more predominates over light-pressure.

The excessive transparency of space seems limited to our own extensive neighbourhood, for in remote regions opacity will set in sooner or later, and all stray radiation—however enfeebled by distance—will sooner or later be re-absorbed, with perhaps exciting and generative material consequences. The birth as well as the death of matter seems not hopelessly beyond our scope. OLIVER J. LODGE.

Breeding Experiments on the Inheritance of Acquired Characters.

ALTHOUGH I agree with Dr. Kammerer in holding the opinion that somatic modifications do, sooner or later, affect the gametes or reproductive cells in such a way as to produce an inherited development of a corresponding change of structure, I regret that the evidence presented in his lecture printed in NATURE of May 12 is in some respects open to the objection that it is not in accordance with the present state of biological knowledge. Another objection, which may be partly due to the fact that the lecture is only a brief summary, is that the evidence does not include sufficient detail, or precise comparison with controls.

For example, Dr. Kammerer states that "Thanks to its enclosing membrane, the ovary of the Salamandra can be removed from the surrounding tissue as a whole," which, according to the context, is not the case with the ovary of birds. I have never heard hitherto of the existence of an enclosed ovary in any amphibian. Unless I am altogether mistaken, the germinal surface of the ovary is exposed to the coelom in Salamandra as in other Amphibia, and the ova escape through this surface as they do in birds, and not into an internal cavity of the ovary as, *e.g.*, in teleostean fishes. If the latter were the case it would be very difficult to understand how ovarian transplantation could be carried out as in Kammerer's experiments.

The fact that Mendelian segregation occurs when naturally spotted Salamandra is crossed with naturally striped Salamandra, but not when it is crossed with experimentally striped specimens, suggests that in the former case the striped character is gametic, while in the latter it is not. But if the experimentally striped character is not gametic, what becomes of the heredity? Kammerer says doubtless both are inherited, but the long-established character obeys the Mendelian law, the new character does not. But T. H. Morgan has shown that new gametic characters in Drosophila obey Mendelian laws from their first appearance. Newness or oldness has nothing to do with Mendelism. A slight degree of heredity is possible, then the experimental striping causes only a slight change in the gametes. Then I presume the natural striping has been caused by exposure to yellow surroundings (soil) for thousands of generations and has become completely gametic, or almost so.

The difference in Mendelian behaviour then would be due to the fact that the natural striping is almost entirely gametic, the experimental striping almost entirely somatic. Such a result would agree with the result of my own experiments on the production of pigment on the lower sides of flat-fishes, supposing it to be true that spotted salamanders occur in Nature on dark ground, striped (yellow) specimens on light or yellow ground.

On the other hand, in the experiments on the results of ovarian transplantation Kammerer puts forth the extraordinary conclusion that the soma of the naturally striped female has no influence on the ova derived from a spotted female, but the artificially striped soma makes the ova derived from a naturally spotted female behave as though they came from a striped female. Here we have a complete gametic change due to somatic influence, while according to the Mendelian experiments there was little or no evidence of gametic change. Such contradictory results *may* be true, but it would require a great deal of corroboration to prove them.

Kammerer states that the case of *Ciona intestinalis* affords an *experimentum crucis*. He certainly exhibited photographs of living Ciona in the parents of which the siphons had been several times amputated. In these young specimens the siphons were "monstrously long," and had been so "from birth." Putting aside the fact that Ciona is not, I believe, viviparous, where were the controls? I have a very strong suspicion that all young Ciona when extended under favourable conditions (*e.g.* supply of oxygen and food) have "monstrously long" siphons. The evidence required is a large number of exact measurements, under the same conditions, of the siphons in the young of parents which were subjected to amputation, and in those of uninjured parents. J. T. CUNNINGHAM.

East London College, Mile End, E., May 12.

Vertical Change of Wind and Tropical Cyclones.

THE first step towards forming an opinion about the physical processes which operate in the formation and maintenance of tropical cyclones is a clear understanding of the structure of the atmosphere in which the formation takes place. A feature of the atmospheric structure which is gradually asserting itself is the resilience of stratification due to the increase of potential temperature with height. We have always recognised isothermal structure as stable, still more so an inversion of lapse rate; but, when one thinks of it, it is clear that the datum for stability is the lapse rate of the saturation adiabatic for upward movement, and that of the dry adiabatic for downward movement. Anything on the isothermal side of these lines implies stability and resilience upon displacement, gradually and continuously increasing up to the isothermal condition and beyond that to inversion.

Since the stratification is only disturbed by saturated air sufficiently warm, the successive layers of the atmosphere in ordinary conditions may be regarded as independent layers, easily capable of motion along surfaces of equipotential temperature, but unable to move up or down across those surfaces. In this respect the layers are like a pack of cards, deformable with a certain amount of resilience, very slippery, but not interpenetrable. The impenetrability of one layer by another is quite inexorable at the bottom, where there is a discontinuity of density between land or water and air, and at the top of the troposphere, where there is thermodynamic discontinuity no less effective in the end, though the effort involves much greater sacrifice in the way of displacement required to produce the necessary resilience. Between these two extremes of resilience the surfaces of equipotential temperature are nearly horizontal. Expression is usually given to the principle of resilience by regarding the motion in any layer as being limited to the horizontal. Of course, the limitation excludes the cases of penetrative convection which sometimes occur, and also the eddy effects due to the motion of a layer relative to the next above or below. But one is as rare as heavy rainfall, and the other, though never absent, is very small in magnitude. Thus for a first survey both may be left out of account.

Also, to begin with, it is best to think of the atmosphere as made up of a number of layers of finite thickness, and not attempt the gradation of an infinite number of layers of infinitesimal thickness. There is often a natural sorting of the structure into irregular strata; but, for the moment, let us think of twenty layers each half a kilometre thick between the ground and the stratosphere, the two boundaries the resilience of which must eventually balance the internal stresses of a quasi-permanent cyclonic vortex.

The motion in each of the twenty layers except the lowest will adjust itself to the distribution of pressure in that layer. The law of the lowest stratum is different. In consequence of surface friction there is a flow across the isobars, with all the disturbing consequences thereof.

As we regard the undisturbed medium as a pile of twenty horizontal layers, so we must regard a cyclonic system as made up of a number of independent layers. We must consider the vortical motion produced in the medium as twenty separate rotating discs, not as a unified rotating column. There is practically nothing in the structure to prevent the slipping of one disc of revolving fluid over another to any extent. The unit of cyclonic activity is not a column reaching from earth to heaven, but a layer, say half a kilometre thick, with a mass of fluid revolving according to its own laws between the upper and lower boundaries.

In these circumstances, if the centres of the revolving masses were accurately superposed to begin with, it would be a marvel of Nature if they remained so. Since pressure is transmitted, the displacement of one would alter the distribution of pressure for all beneath, the inflow at the bottom would affect the mass-distribution of those immediately above, and the relative motion at the surfaces of separation would add further complications.

If all this be correct, what might once have been a vertical revolving column, in a stream of which the velocity varied with height, would soon have become a number of separate and more or less degraded revolving discs. If there happened to be a thick enough layer in the original medium without any height-change of velocity, there might be enough organised rotational energy to preserve the original identity: otherwise the energy would soon be lost in eddies and ultimately in frictional heat.

I am not sure whether Mr. Banerji (NATURE, May 19, p. 668) realises that that was the kind of structure which I had vaguely in mind three years ago when I wrote the remarks in Geophysical Memoir, 19, to which he refers. The lapse of time has enabled me perhaps to think it out more clearly and to develop further the condition for no change of velocity with height. If one imagines a number of masses of saturated air overcoming the resilience locally, passing through a series of superposed layers of air and removing therefrom automatically, by eviction, a vast quantity of air amounting in the aggregate to millions of tons, each layer must set up its own scheme of pressure and rotation independently of the others. As a means of making a rotating column the experiment could scarcely succeed if, by the time that the removal was complete, the centres of the upper systems were displaced horizontally a long way from the lowest; the superposed pressures and the incidental relative motions would certainly spoil the symmetry and in time destroy the unity of the system.

The monsoon winds, of the peculiar behaviour of which Mr. Banerji speaks as being sufficient to account for the movements of the cyclonic storms in Indian seas, belong to the lowest kilometre and are therefore not properly amenable to the distribution of pressure. To my mind surface winds are primarily disturbers and destroyers of ordered vortical motion. A well-organised cyclone may succeed in feeding on their energy and thus increasing its own vigour in the way which Dr. Fujiwhara described recently to the Royal Meteorological Society. In Geophysical Memoir, 19, I was not dealing with that part of the subject, but only with the initial stages of the creation of the vortex.

NAPIER SHAW.

April 27.

The Relation of Actinium to Uranium.

AT present the most likely view of the origin of the actinium series is that uranium II undergoes a dual change in which about 96 per cent. of atoms form ionium and the radium series, and the remainder form uranium Y, the product of which, proto-actinium, is the parent of the actinium series. An alternative view is that uranium I undergoes the dual change. In 1917 Piccard from a consideration of the Geiger-Nuttall relation put forward the view that the actinium series might arise from an isotope of uranium, actino-uranium, of atomic weight 240, present in ordinary uranium to the extent of about 8 per cent. Partly from experimental work carried out by Mr. W. P. Widdowson and myself, and partly from a survey of certain general relations in radio-activity, I have come to a different view, which I think represents the facts more adequately than these others. I agree with Piccard in thinking that the parent substance of the actinium series is an isotope of uranium, of atomic weight 240, not genetically connected with it; but differ principally in thinking the atomic weight of actinium is not 232, and that uranium Y is not the immediate parent of proto-actinium.

The scheme is as follows:

Element.	Period.	Atomic Number.	Radiation.	Atomic Weight.
Actino-uranium I .	$>5 \cdot 10^9$ years	92	α	240
Uranium Y_1 . .	25·5 hours	90	β	236
Uranium Y_2 . .	Probably very short	91	β	236
Actino-uranium II .	$>2 \cdot 10^4$ years	92	α	236
Parent of proto-actinium . .	>20 years	90	β	232
Proto-actinium .	$<1·2 \cdot 10^4$ years	91	α	232
Actinium . . .	20 years	89	β	228
Radio-actinium, etc.	19·5 days	90	α	228

This scheme was arrived at from a consideration of the periods of corresponding members of the three disintegration series. Successive radio-active transformations may be classed in three ways:

(1) Four α-particles (five in the uranium series) follow each other without the expulsion of a β-particle.

(2) An α-particle is followed by two β-particles in succession and then an α-particle.

(3) An α-particle is followed successively by a β-, an α-, and a β-particle.

In the three known examples of the first type each product has on the average 800 times the period of its successor. (For the uranium series the ratio is 766, for the thorium 764, for the actinium 918.) Yet the periods of average corresponding members of the three series (in the order given) are in the proportion of 5×10^5, 50, and 1. Now the difference in atomic weight between the uranium and the thorium series is 2 only. I have assumed that if a time ratio of 5×10^5 to 50 corresponds to 2, a ratio of 50 to 1 corresponds to so small a fraction as to be negligible. If this be justifiable the atomic weights of the thorium and actinium series become identical. It follows that actinium has an atomic weight of 228 and so cannot be genetically connected with uranium if α- and β- be the only particles expelled in radio-active transformations.

I have found interesting relations connecting the periods of the bodies of the second and third types of successive transformations, but the only thing necessary for the scheme to be deduced is that in both these types the period of the first β-particle is greater than that of the second. There are in all, excluding the change, parent of Pa$\rightarrow$Pa$\rightarrow$Ac$\rightarrow$RdAc, ten examples of the second and third types known, in all of which this relation holds. It is consequently not unreasonable to suppose that the parent of proto-actinium has a longer period than actinium and consequently cannot be uranium Y. As the latter is very probably genetically connected with actinium, and is undoubtedly a product of a body of atomic number 92, it must be an isotope of the parent of proto-actinium probably with an atomic weight 4 units greater. To connect it with the parent of proto-actinium it is simplest to suppose that it is followed by a quick-changing product uranium Y_2, corresponding to uranium X_2, which is the parent of an isotope of the original actino-uranium, and this immediately precedes the parent of actinium as shown in the table above.

The scheme, so far as I am aware, does not seriously contravene the results of experimental work, and appears to be nearer what one would expect by analogies from the thorium and uranium series and the lower part of the actinium series than those previously proposed. None of the new proposed data given in the table contravene the Geiger-Nuttall relation. Moreover, they appear to make Fajan's rules connecting the order of the atomic weights of isotopic α-ray and β-ray bodies with the order of their periods more nearly exact than hitherto they have appeared to be. To Fajan's α-ray rule there have been hitherto three exceptions; on the new scheme there is only one. The two exceptions to his β-ray rule do not exist in the new scheme.

Our experimental work on the relative activity of uranium and its products in pitchblende leads to a ratio in the amounts of actinio-uranium and uranium I in uranium of about 5 to 95. But the experimental results to be expected on the assumption that uranium II breaks up dually in this proportion to form the actinium and radium series lead to so similar a result that at present our experimental work is insufficiently advanced to lead to a decision.

Mr. W. G. Guy in this laboratory has been for some time engaged with me in repeating Dr. O. Hahn's work on uranium Z as described in the latter's publication of 1921, and has independently come to very similar results to those described in Hahn's second and recent paper. He confirms Hahn's important result that uranium X_1 breaks up dually, in both cases with the emission of a β-particle to form uranium X_2 and uranium Z in a ratio of about 997 to 3. He has also measured the periods of uranium Y, uranium Z, and uranium X_2 accurately, and finds them to be 25·5 hours, 6·69 hours, and 70·5 seconds respectively. These agree with the published values. Dr. Hahn does not appear to have noticed that the branching ratio, which he gives as 996·5 to 3·5, is approximately equal to the reciprocal of the periods of the two bodies formed. This agreement may be a coincidence. If it is not, it would not be difficult to deduce from it information which might throw light on the mechanism of disintegration.

A. S. Russell.

Dr. Lee's Laboratory, Christ Church,
Oxford, May 3.

Slag mistaken for a Meteorite at Quetta.

Wide publicity has been given in the Press to a story of a fall of a large meteoric mass in Quetta, Baluchistan Agency.

The Geological Survey of India has always paid particular attention to falls of this kind, and, within an hour of the receipt of the news in Calcutta, was in telegraphic communication with the authorities in Quetta, and the receipt of specimens was anxiously awaited. Ultimately, approximately two hundred-weights of material were carefully examined, and found to be entirely a glassy slag in which were embedded bits of iron wire and thin iron bands.

So far as can be judged, the sequence of events was as follows: A large stack of baled bhoosa (chopped straw) of about five hundred tons weight was fired by a flash of lightning during a heavy thunderstorm, and a mass of slag some five tons in weight was left behind. A bystander suggested that this mass was of meteoric origin.

G. H. Tipper.

Geological Survey of India, Calcutta,
March 11.

Vision and Light Sensitiveness.

In my former letter (NATURE, April 14, p. 498) I endeavoured to avoid dogmatism on this very obscure subject, and aimed rather at stimulating further research in what seems to be a phenomenon of great importance Though I go all the way with Mr. Locket (NATURE, April 28, p. 570) in cautioning the utmost reserve in accepting my hypothesis, especially as, in my letter, it is supported, and designedly so, by no more definite evidence than the flicking of a fly; still, in the interests of research, I feel called upon to add some comments to his letter.

I have collected a large mass of evidence which, however, cannot be published *yet*, as it is far from complete. Moreover, as much of it appears to contradict the conclusions of great authorities, some of whom Mr. Locket mentions, it obviously cannot be urged until I have repeated each essential portion of it more than once, and explored in each experiment every possibility.

First of all, then, I submit that it is of the utmost importance to differentiate clearly between *sensitiveness to light* and *vision*, both in experiment and in deduction; for vision is by means of eyes, light sensitiveness not necessarily so. Plateau has proved (*Journal de l'Anat. et de la Physiol.*, 1886, p. 431) that certain myriapods distinguish between light and darkness by the general surface of the skin; though Forel and Lord Avebury have proved this not to be the case with ants. It would be interesting to know if it is so in Typhlopone, where there are no eyes. Wherever there are eyes I think we may, for the present, assume that there is sensitiveness to light, but this is far different from presuming that there is vision. I have been unable to discover any evidence for vision in the Epeiræ studied, or in *Tegenaria domestica* or *Agelena labyrinthica*, when proper precautions have been taken. In these instances a fly, with the wings cut off, will not disturb them; but, if the fly have wings or stumps of wings with which it can buzz in the forceps then the case is very different. The necessity for taking every precaution may be shown by the extreme sensitiveness of *T. domestica* to the presence of carbon dioxide, so that even slight breathing on the specimen causes movement. Though this spider will revive after a collapse of five minutes in a vacuum at 6 mm. of mercury, though it will live for some minutes apparently with comfort in coal gas, an atmosphere of carbon dioxide kills it instantly.

Another precaution, most essential to success, is to avoid casting shadows on the animal under observation; in the case of the black-bellied tarantula (*Lycosa narbonnensis*), and in very many others, there is a manifest seeking for light. This is most apparent when the young are on the parent's back. Here, possibly, lies the solution of this enigma. This spider carries her young on her back with, so far as I can see, no food for about six months. These fasting youngsters grow strong, expend energy, and certainly do not become emaciated. Do they get their energy from the air alone? Do they possibly get it from the sun, as vegetable life does? I cannot yet answer this. Here the investigation would extend from the pigment-spot in *Euglena viridis* to the facts of modern heliotherapy.

Turning to Mr. Locket's remarks on the ants, the species employed for the most part were *Formica fusca* and *F. sanguinea*. In these insects Forel (*Rec. Zoolog. Suisse*, 1887) has proved that there is normally sensitiveness to light which is destroyed by varnishing the eyes, and Lord Avebury mentions ("Ants, Bees, and Wasps," 13th edition, p. 405) their sensitiveness to "ultra-violet rays much beyond our limits of vision." This same authority says quite plainly (*op. cit.* pp. 273, 272, 266, 256, 251) of *Lasius niger* that, "though it seems clear that they are helped by sight," they do not trust much to their eyes, and are "little guided by . . . surrounding objects." In another experiment, "if she [the ant] were much aided by sight, then she would have had little difficulty in finding her way back." On the other hand, he concludes from further work (pp. 268, 270) that by altering the *position of the lights* "the ant went wrong," and that, "in determining their course the ants are greatly influenced by the direction of the light." Here the difference between mere *light sensitiveness* and *vision* is strongly supported.

Forel's experiment ("Senses of Insects," pp. 124-128), noted by Mr. Locket, had seemed to me conclusive until I repeated it, taking care to supply several control ants the eyes of which were varnished with a transparent fluid. From the results I concluded that the difficulty in finding home was as much due to the annoyance of being handled and varnished as to being hoodwinked.

When working on the flies, including both species mentioned by Mr. Locket, I did not varnish the eyes; I used a second sheet of glass between the fly's back and the moving object. Still this experiment with the second glass was not repeated often enough to allow me to state my results with assurance, and I agree with Mr. Locket that varnish should have been employed. With regard to the motion of air,—and this is the kernel of Commander Hilton Young's hypothesis,—vibration due to sound waves and simple air currents must be treated separately. Many insects and spiders are extremely sensitive to the former, and there can be no doubt that the fly is sensitive to the latter, though I doubt whether to the extent suggested by Commander Hilton Young.

I cannot agree with Mr. Locket in his use of the ocelli as an explanation. It was, I think, Johannes Müller's opinion that they were especially useful for close vision. But we have the authority of Plateau, Forel, Réaumur, Marcel de Serres, Dugès, Lord Avebury, and others, that varnishing of these organs made no difference. Though many, with Forel (*Rec. Zoolog. Suisse*, 1887), Lebert ("Die Spinnen der Schweiz"), and Pavesi (*Ann. Mus. Civ. di Genova*, 1873, p. 344), suggest that the ocelli serve for vision in semi-darkness, and the eyes for vision in full light, the experiments I have made in this field, necessarily obscure, have been fruitless, so far as I have been able to devise them.

The instance of the male Attid, given by Mr. Locket, I have not worked on yet; as well as the many examples of what appears to be lethal fascination as in *Mantis religiosa*. There is clearly an enormous amount of work to be done,—so far I have not touched the scorpions,—and I speak, as I did in my former letter, only of those species which I have studied, necessarily few relative to the vast kingdom under discussion. So I can end no better than again, with Mr. Locket, cautioning reserve.

J. P. O'HEA.

St. Beuno's College, St. Asaph,
April 20.

Phosphorescence caused by Active Nitrogen.

In a letter under this title in NATURE of May 5, p. 599, Prof. E. P. Lewis announces his recent discovery that active nitrogen excites phosphorescence in a number of solid compounds. I should like to mention that during the summer of last year I observed the same phenomenon in the case of an

X 2

aluminium compound, which does not, however, occur in the list of substances given by Prof. Lewis.

In resuming, during July last, a series of spectroscopic investigations begun in 1913 on the lines of earlier work by the present Lord Rayleigh and Prof. Fowler, I attempted a preliminary observation of the spectrum resulting from the introduction of the vapour of aluminium chloride into the stream of active nitrogen. After a long exposure a solid deposit was produced on the inside of the afterglow tube, and when the stream of active nitrogen was passed through the same tube a few days later the deposit exhibited a bright green fluorescence. It was hoped that this observation might be recorded in a future paper, after opportunity for further spectroscopic work had occurred. In view of Prof. Lewis's announcement, however, perhaps this note by way of corroboration is not out of place.

W. JEVONS.

Physics Department,
Artillery College,
Woolwich, May 11.

The Dissolution of the Conjoint Board of Scientific Societies.

ACTING under the instructions of the Executive Committee, we have now wound up the affairs of the Conjoint Board of Scientific Societies.

Everything connected with the "List of Scientific Periodicals" has been placed in the hands of the Trustees who have been appointed to carry out this publication. The work on the List is now well advanced.

The Royal Society has agreed to accept the custody of filed records and documents related to the work of the Board and its Committees, with the exception of that just mentioned. These have now been lodged with the Society, except the records of three Committees, at present in the hands of their secretaries for final revision before lodgment with the Society.

Copies of the proceedings of the Board have also been deposited with the British Museum, the Royal Society of Edinburgh, the Patent Office, Sir Arthur Schuster, Sir Herbert Jackson, and Prof. W. W. Watts. Sets of printed matter have been also handed to the Department of Scientific and Industrial Research, the National Physical Laboratory, the Science Library, the University of London, the Imperial College of Science and Technology, the British Museum (Natural History), and the London Library.

HERBERT JACKSON.
W. W. WATTS.

May 14.

The Capture of Electrons by Swiftly Moving Alpha Particles.

THE swiftly moving α-particle produces a large number of ions in its passage through a gas, as is evidenced by the beautiful Wilson photographs of α-ray tracks. It is a matter of some surprise that at the act of ionising a molecule, or immediately after, the α-particle does not attach one or more of the free electrons to itself. The approach is very near and the force is that due to a double charge.

The experiments of Rutherford, Marsden and Taylor, and others indicate that the swiftly moving α-particles begin to take up electrons when the velocity has decreased to 0·4 of the initial value ($v_1=0{\cdot}4\ v_0$). The recent experiments of Henderson (Proc. Roy. Soc., January 1, 1923) indicate that at this velocity the α-particle takes up one electron. It then continues its smashing career through matter without change until the velocity is reduced to 0·15 of the initial value ($v_2=0{\cdot}15v_0$). At this velocity, approximately, the α-particle takes up a second electron and becomes a more or less harmless atom of helium.

The limiting velocities at which the α-particle captures the first and then the second electron seem to be rather definitely fixed. The initial velocity from radium-C is $v_0=2{\cdot}06\times10^9$ cm./sec. The velocity at first capture is $v_1=0{\cdot}4v_0=8{\cdot}2\times10^8$ cm./sec. The velocity at second capture is stated by Henderson to be at least as small as $v_2=0{\cdot}15v_0=3{\cdot}1\times10^8$ cm./sec.

It is desired to point out here that this failure to capture an electron may be due to the high velocity of the α-particles. The free electron will at once start toward the α-particle. If the latter is moving with a velocity greater than the velocity of fall (parabolic velocity) of an electron into the K ring, the electron will fail to reach the K ring and effect a combination. Having this situation in view, I have calculated the limiting parabolic velocity for an electron falling into the K ring of (1) a doubly charged α-particle and (2) one having a single charge. The radius of the K ring is given by $a=h^2/4\pi^2meE$, where E is the excess nuclear charge in each case. This velocity is given by $\frac{1}{2}mv^2=Ee/a$. From these considerations the calculated velocity for the first case is $v_1=6{\cdot}2\times10^8$ cm./sec. In the second case the charge E is single, and the velocity $v_2=3{\cdot}2\times10^8$ cm./sec. The experiments are necessarily not very exact, but the agreement is sufficiently close to suggest that this may be the proper explanation of the action.

From this point of view, all α-rays, of whatever initial velocity, should capture the first and second electrons at the same velocity. This is a matter of sufficient importance to determine experimentally.

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Recent Auroræ.

MAGNETIC disturbances and associated phenomena have perhaps a special interest when they occur during the minimum period of sunspot activity, owing to the comparative rarity of these events at this time. When, therefore, I read in NATURE of April 21, p. 534, the account by Father Cortie of the recent disturbances, it reminded me of observations I had made of the aurora in activity on the dates referred to. On February 25, in a very clear sky, with a nine-days-old moon shining, the northern horizon was seen to be brightly illuminated by auroral light at 8.45 P.M. for about half an hour, but no streamers were seen. On March 24, again in first-quarter moonlight, but a very hazy sky, I saw an auroral display of unusual beauty at 9 P.M. over Bassenthwaite Lake. The arch was elevated ten degrees, with streamers and lances shooting upwards for, in some cases, another thirty degrees. The length of the arch I could not measure, owing to each end being hidden by lofty mountains, but it was visible for sixty degrees. It was clear-cut below, and merged gradually into the moonlit haze above.

The reflection of the streamers in the perfect mirror-like surface of the lake, and the shining arch flanked by snow-capped heights, dimly seen in the misty moonlight, combined to form a picture of indescribable beauty.

W. B. HOUSMAN.

Seaton, Cumberland,
April 25.

Recent Experiments in Aerial Surveying by Vertical Photographs.[1]

By Prof. B. Melvill Jones and Major J. C. Griffiths.

I.

It is proposed to describe in these columns the results of experiments on aerial surveying that have been in progress at the University of Cambridge since 1920. The experiments were made possible by the co-operation of the Royal Air Force and the Department of Scientific and Industrial Research with the chair of aeronautics at Cambridge. They were suggested in the first place by Mr. Hamshaw Thomas of Cambridge as the result of his experiences of air-mapping in Palestine during the War. The authors wish to acknowledge their debt to Mr. Thomas, not only for the original suggestion, but also for valuable advice during the progress of the work.

To make an accurate survey by air, it is necessary to have information concerning the position and orientation of the camera at the moment of exposure. If the ground concerned is flat and the tilt of the camera is known, the photograph can easily be re-projected to give a true plan. When the ground is hilly, two photos of the same area, taken from known points, and with known tilts, will provide information from which a complete model, or map with contours, can be constructed.

If three points that are accurately known in position occur in a photo, it is possible to find the position and orientation of the camera from internal evidence in the plate itself. This process is called "re-section." It is thus theoretically possible to map an indefinite area of country from a single base of three known points, for these points could be made to occur in the first two photos, which could then be used to determine the positions of other points, from which further photos could be re-sected, and so on. In practice this process would lead to accumulations of error which, with the methods yet available, would soon become prohibitively large. It is for this reason necessary, if the re-section method is to be used at present, to provide a net of ground-surveyed control points such that three will occur in most, if not all, the photographs.

When the aerial map is merely required to record changes, or to fill in detail in a country that has already been closely surveyed, as, for example, in the war mapping of the Western Front, or in the re-mapping of towns in peace, many accurately surveyed points will already exist and the re-section method will be the obvious one to use. When, however, the problem is to map large areas of unsurveyed country, as, for example, the interiors of Australia or Africa, the cost of providing so many ground-surveyed points will generally be prohibitive. This will be especially the case when the country is flat and heavily wooded.

It is, however, precisely in connexion with large areas of this nature that the outlook for aerial surveying, on a large scale, is most hopeful. In such cases it will not, in general, be practicable to spend much money per square mile of survey, so that it becomes necessary to employ methods that neither require a close preliminary ground survey nor involve too much office labour per photo. Both these conditions rule out the re-section method for work of this class.

Now exact determination of the position and orientation of the camera in space, by methods that are independent of the photo itself, is a matter of great difficulty, but it happens that an exact plan of level country can be constructed from overlapping photos, without knowing the exact position of the camera, provided that all the photos are taken from the same height and with the camera axis vertical. The reason for this is that all such photos will show a true plan of the ground to the same scale, and therefore they can be shuffled together, until the detail joins up everywhere and a true plan is formed.

If, therefore, a camera can be kept at a constant height, with its axis vertical, and moved about over the ground, so that the whole country is covered by overlapping photos, it will be possible to construct a continuous plan of the ground from contact prints straight from the original negatives; and it will not be necessary to provide for known points to appear on each photo, or to determine the position of the camera at each exposure. Moreover, the heavy office work involved in re-secting and re-projecting each photo will be avoided entirely.

Such a process is strictly accurate only when applied to absolutely flat country, but when working from 10,000 feet, as we do, undulating country up to about 500 feet local differences of level can be classed as sufficiently flat from this point of view. It must also be remembered that flat country is often the most difficult to survey from the ground, and is therefore the country in which an alternative method is most required.

We are thus led to the conclusion that the economical mapping of moderately flat country, by means of vertical photographs, depends upon the accuracy with which the camera can be maintained at a constant height, with its axis vertical, and upon the ability of the pilot to fly so as to cover all the ground with photographs that will neither overlap too much nor leave gaps. The experiments at Cambridge have been concerned mainly with the accuracy obtainable in these operations, given suitable apparatus and sufficient training in air routine.

Finding the Vertical.

The problem of keeping a constant height is quite straightforward and easy to understand; the only difficulty is to do it. The problem of keeping the camera axis vertical is complicated by the fact that all forms of apparatus that are designed to indicate the vertical are disturbed by horizontal accelerations of the aeroplane, which often persist in one direction for so long as twenty seconds at a time. It is possible to devise gyroscopical instruments that will seek the vertical so slowly as to average out these disturbances, but much experience has been gained with instruments of this type during the War, and this experience was not encouraging, mainly owing to the liability to failure of the delicate apparatus required.

In aerial surveying it is, however, necessary to fly

[1] Substance of two lectures delivered at the Royal Institution on February 15 and 22.

very straight and steadily in order to cover the ground correctly, and, when one is flying straight and steadily, simple vertical indicators such as the spirit level indicate truly.

Now it had been found, in connexion with bombing experiments during the War, that it is comparatively easy to fly very straight and steadily when no other condition is imposed, but that it is much more difficult to do so when trying to pass over a pre-arranged point. The reason for this is that the pilot normally estimates the horizontal and vertical by reference to the horizon, and, when forced to look at the ground beneath him, is quite unable to distinguish the true vertical from the apparent vertical as distorted by acceleration.[2] It is obviously necessary to look at a point in order to get over it, so that the reason for the distinction between merely flying straight and flying straight over an object is at once apparent. To overcome this difficulty it is necessary to devise methods of carrying out the survey with the minimum attention to the ground beneath.

We decided to divide our experiments into two groups as follows:

1. To study the accuracy with which it is possible to keep the camera at a constant height with its axis vertical, when the difficulty of finding a predetermined track is reduced to a minimum.

2. To find out how to fly over a predetermined straight track without losing accuracy from that determined above.

In connexion with the first group of experiments, we were fortunate in having near Cambridge a stretch of very flat country covered with numerous well-mapped and easily identified points and traversed by two large straight canals, more than twenty miles long, called the Bedford Levels.

It is easy to fly down a long straight landmark of this nature with very little attention to the ground immediately beneath. We therefore flew along these canals at about 10,000 feet, keeping as straight and level as possible, and taking a series of photographs at regular intervals. We then developed these photos and, from them and a 6-inch Ordnance Map, calculated the position and orientation of the camera at the moment of exposure by the method of re-section.

The re-section was very laborious, but eventually, after about two years' work, we obtained results for 170 exposures, and these showed a probable error of tilt of about 1° from the vertical and a probable variation of height from the mean of a flight of 40 feet. The distribution of errors in both tilt and height was quite normal.

From this data it is clear that the tilt of the camera axis from the vertical seldom exceeded 2° and that the height of the camera seldom varied more than 100 feet from the mean of each flight. Simple calculations, supported by previous experience in Palestine, lead to the conclusion that such errors should not introduce serious errors into maps made on the assumption that the axis is vertical and the height constant. This excludes, of course, errors that are cumulative over large distances.

[2] It is easily shown that a pilot, looking down at a point beneath him and trying to fly so as to pass over it, will tend to fly along one of a series of curves of which the equation is $p\rho=$const., where p is the perpendicular from the origin on the tangent from the point where the radius of curvature is ρ. These curves in general never pass over the required point (*i.e.* the origin).

COVERING THE GROUND WITHOUT GAPS.

The second problem was to cover the required country to be surveyed without leaving gaps and without losing accuracy. It is on this problem that most attempts at commercial surveying have broken down, the primary cause of failure being the inability of the pilot to distinguish between the true and apparent vertical. So long as the pilot is allowed to look constantly down at the ground, in an endeavour to cover it accurately, tilts up to six or more degrees are liable to occur, and the tracks that are made under these conditions are often so curved as to cause large gaps between the strips of photos.

By experiment we have found that the best way to solve the difficulty lies in allowing the pilot to locate his position by reference to the ground beneath, at the start of each flight only, and insisting that he must fly henceforward without further reference to the ground.

To do this in such a way that successive flights on the out and return journeys will cover the ground in parallel strips, it is necessary, first, to find and allow for the wind at the height in question. This we do by a method that was developed by the Air Ministry for purposes of aerial navigation, and we have brought the routine to such a pitch that within ten minutes after reaching the survey height, 10,000 feet, we can find the wind and make all necessary calculations for compass courses, etc. It requires considerable training and experience before this can be done.

However good the methods employed, the strips on successive journeys will not be exactly parallel, and, since they are located only at one end, their length will obviously be limited if gaps are to be avoided. We find that this limit comes out at between 10 and 15 miles. The starting points for the strips are either marked on existing maps or on preliminary strips of photographs, taken along the edges of the mosaic at right angles to the mosaic strips; these preliminary strips are called "indication strips."

The pilot, therefore, begins by getting over a point, as accurately as he can, and then taking up a pre-calculated compass bearing as quickly as possible. A difficulty may here be experienced owing to the well-known fact that compasses on aeroplanes are affected by a change of course and do not settle down on a true bearing until the aeroplane has been flying straight and steadily for some time. If the pilot has managed to get over the starting point while flying on the correct bearing, this difficulty will not arise, but when working from tractor aeroplanes, as we are forced to do, one cannot always manage this, because the lower plane obstructs the view of the point during the approach, unless the approach is made in a curve.

To overcome this difficulty we use an apparatus designed by the Royal Aircraft Establishment. This consists of a free gyro that can maintain its orientation in space for some ten minutes, without reference to the movements of the aeroplane. We release this gyro while flying on the required course, just before reaching the starting point, and use it to return to the correct course immediately after passing the point. We consider that an apparatus of this nature will always be a great help in aerial surveying, especially when working from tractors, but we think that a survey could be successfully carried out without it when working from pushers. When flying without this apparatus, either more skill is required, or the beginnings of each strip will be rather less accurate than they might be.

The photographic strips themselves can be kept straight by flying on a distant point near the horizon, but this operation can be much assisted by another gyro instrument that controls the rudder through a relay and thus keeps the aeroplane on a straight course automatically. This apparatus relieves the pilot of the most fatiguing part of his work and, by allowing him to concentrate more on such things as maintaining constant height and speed, improves the general quality of his work. We have carried out surveys both with and without this instrument, and, while we have proved that accurate work can be done without it, we should always recommend its use in any large surveying scheme.

Area covered in a Flight.

We have found from experience that 100 sq. miles is about the area that can conveniently be covered in one flight. This requires about 80 minutes flying on the actual mapping and about three hours from ground to ground. This amount of work is about what a crew can perform regularly, day by day; hence it follows that aerial surveying by these methods can be carried out at the rate of about 100 sq. miles per day. If the separate strips are made ten miles long, the average day's work will, therefore, cover a square of ten miles to the side.

We have found that an area of 100 sq. miles, involving about 130 photos, forms a convenient unit for compilation, for, although we have compiled a very successful map of 225 sq. miles in one unit, we consider this to be too large for economical work. The method, therefore, that we favour for mapping large areas, is to compile the prints of each day's work into separate mosaics and, after reproducing these to any required scale in a large camera, or photostat, to fit these larger units together in the same way as the individual prints were fitted.

(*To be continued.*)

Science and Radio-Communication.[1]

By Sir Richard Glazebrook, K.C.B., F.R.S.

Problems in which there is a close connexion between theory and practice can be found in every branch of engineering, perhaps with more striking effect in electrical and metallurgical science, in the laws of stress and strain in structural materials, and in the fatigue of parts subject to vibration, rather than in the questions which pertain more closely to the domain of civil engineering. Let me deal first, briefly and incompletely it must be, I fear, with that branch of electrical engineering—radio, or wireless telegraphy—which at present exercises such a fascination over the popular mind, which is already and will be to a greater extent in the future a link to bind together all nations of the earth. Sir William Anderson, in the first James Forrest lecture delivered thirty years ago, refers to Preece's early experiments between Lavernock and Flatholme, a distance of eight miles, as a startling consequence of electro-magnetic theory. Now the earth is girdled with a wireless chain depending from two, or at most three, great stations. I have just received from the International Union for Scientific Radio Telegraphy details of a scheme for the determination of longitude in which the principal co-operating stations will be Bordeaux, Annapolis, and Pearl Harbour.

In the year 1865 Clerk Maxwell read before the Royal Society his paper on "The Equations of the Electro-Magnetic Field." It was an attempt, which has stood the test of time—the conditions which led Lorentz and, later, Einstein to introduce certain modifications were not dealt with by Maxwell—to apply mathematical reasoning to those principles, enunciated by Faraday, on which the construction of generators and motors, transformers, and practically all electrical machinery is based. This reasoning led him to the result that the effect of changes in an electric current in a conducting wire would be propagated through space with a speed depending on the two constants[2] which define the electric and magnetic conditions of the medium surrounding the wire. The values of these constants for air can be found from electrical considerations, and hence the velocity with which electro-magnetic disturbances are propagated can be calculated. To quote his words:

> "We now proceed to investigate whether these properties of that which constitutes the electro-magnetic field, deduced from electro-magnetic phenomena alone, are sufficient to explain the propagation of light through the same substance," and his conclusion is: "The agreement of the results seems to show that light and magnetism are affections of the same substance and that light is an electro-magnetic disturbance propagated through the field according to electro-magnetic laws."

Maxwell found that when the calculations were made the resulting value for the velocity was approximately equal to the velocity of light. The work was extended in his "Treatise on Electricity and Magnetism," published in 1873. The values of the velocity of light and the velocity of propagation of electro-magnetic waves were not known then with present-day accuracy, and he concludes that they are quantities of the same order of magnitude. A glance at present-day[3] figures shows that they are identical, and the electro-magnetic theory of light is universally accepted. Nor was the result true only for propagation through air or interstellar space; such observations as were then available showed that, in all probability, it held for all transparent media, though there were discrepancies, known now to

[1] From the James Forrest lecture on "The Interdependence of Abstract Science and Engineering," delivered before the Institution of Civil Engineers on May 4.

[2] The velocity is given by $1/\sqrt{\mu k}$, where k is the inductive capacity and μ the magnetic permeability of the surrounding medium.

[3] Messrs. Rosa and Dorsey of the Bureau of Standards, discussing the various determinations of the electro-magnetic velocity, express the view that the figure $2{\cdot}9980 \times 10^{10}$ cm./sec. is accurate to 1 part in 10,000, while the best result for the velocity of light is, to the same accuracy of measurement, $2{\cdot}9986 \times 10^{10}$ cm./sec. See "Dictionary of Applied Physics," vol. ii.

be due to dispersion, which required explanation. But there was a wide gap between this theoretical deduction of Maxwell and the wireless telegraphy of to-day, which needed many more investigations in "pure" science before the bridge was complete. We at the Cavendish Laboratory—I was a student at the time—implicitly believed in its truth; but no one had received electromagnetic vibrations—at any rate, to his certain knowledge. The method of generating them and the means for measuring them were still to come.

For the former we have to go back to a remarkable paper[4] by a very distinguished honorary member of this Institution, Lord Kelvin. Helmholtz[5] seems to have been the first to conceive that the discharge of a condenser through a wire might consist of a forward and backward motion of electricity between the coatings —a series of currents in opposite directions. Lord Kelvin took up the question mathematically and investigated the phenomena. He showed that under certain conditions there would be oscillations of periodic time $2\pi\sqrt{LC}$, where L is the inductance of the coil, and C the capacity of the condenser. These oscillations must, according to the theory, give rise to waves travelling out into space with the electro-magnetic velocity. Fitzgerald, at a meeting of the British Association, had predicted in 1883 that they might be produced by utilising the oscillatory discharge of a Leyden jar, and Sir Oliver Lodge in 1887 produced and detected them. For their detection the principle of resonance was employed. Any mechanical system free to vibrate has its own period of oscillation, and the application to it of a series of small impulses at intervals coincident with the free period of the system results in a disturbance of large amplitude. So, too, an electric system having capacity and inductance has its own period of electrical oscillation, and, if this coincides with the period of incoming electrical waves, electrical disturbances of a magnitude which can be detected by our apparatus are set up. It is necessary that the receiver and the transmitter should be in tune. Lodge made use of this principle, and, by receiving the waves on wires adjusted to resonance with his Leyden jar and coil, was able to detect them. David Hughes, working in the early 'eighties, had already detected such oscillations, but was discouraged from pursuing the subject.

In 1879, in consequence of the offer of a prize by the Berlin Academy, the attention of Heinrich Herz, then a student under Helmholtz, was attracted to the problem of electric oscillations and their detection. He came to the conclusion that with the means of observation then at his disposal "any decided effect could scarcely be hoped for, but only an action lying just within the limits of observation." The investigation was laid aside, only to be revived in 1886 by a chance observation of the effect of resonance in two circuits which happened to be in tune, and his realisation of the fact that herein lay the means of solution of his problem. His paper "On Very Rapid Electric Oscillations" appeared in Wiedemann's *Annalen*, vol. xxxi. for 1887, and from this experiment came verification of Maxwell's theory, the basis of all our knowledge of wireless.

[4] *Phil. Mag.*, 1855.
[5] "Über die Erhaltung der Kraft," 1847.

Fitzgerald directed the attention of English physicists to the work at the British Association meeting in 1888, and Lodge exhibited many of the effects of the waves at the Royal Institution in 1889. The investigations which led to such brilliant results were inspired by the desire for knowledge; the idea of their practical application was entirely absent. Signalling by wireless waves was not foreshadowed until Crookes suggested it in 1892, and in 1893, the year of Sir William Anderson's lecture, Lodge heard of Branly's coherer and applied it to the rectification and reception of wireless waves. From this started the investigations of many of those whose names as pioneers are familiar to all. But another discovery in pure science was necessary to complete the work.

Edison had shown in 1883 that if an insulated electrode was inserted in an ordinary glow lamp there was a current of negative electricity from the filament to the electrode—the emission of negative electricity from a hot body had been observed by various experimenters—and Fleming made some observations about this date on the Edison effect. In 1904 he applied them to produce a valve rectifier for high-frequency oscillations by connecting one pole of his receiving circuit to an insulated plate or cylinder within a carbon lamp, of which the negative electrode forms the other pole of the receiving circuit. When the filament is made incandescent, negative electricity can readily pass from it to the insulated plate and hence into the receiving circuit; the flow of positive electricity in the same direction is checked; the lamp has a rectifying action.

Dr. Lee de Forest improved this oscillation valve a little later, making it an amplifier as well as a rectifier by placing between the filament and the plate or cylinder a grid of metal wire connected to an external source of electromotive force, by means of which its potential can be varied. There is ordinarily a current of negative electricity passing from the filament to the plate—the plate current it is called—through the interstices of the grid. By varying the potential of the grid this current can be varied, and the conditions can be so adjusted that small changes in the potential of the grid will produce large changes in the plate current; the plate current is passed through the primary of a step-up transformer, in the secondary of which is the receiving telephone, and the effect is thereby made audible. The grid is connected to one pole of the circuit receiving the incoming waves, and the small variations of potential which they produce thus give rise to large variations of the plate current, and hence the sound is amplified. By placing a number of valves in series very large amplifications are possible.

The other uses of the valve are very numerous. It is now employed as a transmitter for wireless work; while it finds many applications as a source, or rather regulator, of vibrations of comparatively short period. The Post Office has used it as an amplifier of speech, while Mr. F. E. Smith has applied it as a source of sound in connexion with the measurement of audibility. The whole of this arose from Edison's observation of the discharge of negative electricity from the heated filament.

To quote again from the first James Forrest lecture: "The engineer must banish from his mind the idea that anything can be too small or too trifling to deserve his attention." The modern development of the valve, through the researches of those who have brought it to its present excellence, has rested on a still smaller entity, the electron, a body with a mass of $0·900 \times 10^{-27}$ grams, about 1/1800 of the atom of hydrogen, carrying a negative charge of $1·591 \times 10^{-20}$ electro-magnetic units[6] of electricity, first glimpsed by Crookes, then proved to exist by J. J. Thomson.

The appearance of a Crookes tube or vacuum tube when carrying an electric discharge is well known. When the pressure is sufficiently reduced, the tube is non-luminous except for a beam of light which proceeds normally from the cathode—the negative electrode—and penetrates into the tube a distance depending on the pressure; this beam constitutes the cathode rays: if the rays strike the glass at the end of the tube, a vivid fluorescence is produced.

Crookes showed that the beam constituted a current of negative electricity; it could be deflected by a magnet. Experiments by Perrin and J. J. Thomson proved conclusively the existence of the negative charge. Thomson showed also that the stream consisted of an assemblage of minute particles—electrons. He measured the velocity of the particles and the ratio e/m of the charge on each to its mass. Further experiments, of which perhaps those of Millikan are the most important, have led to a determination of the charge on the electron, and from this and a knowledge of the ratio e/m the values of e and m are found. These values are the same whatever be the nature of the cathode from which the rays take their origin—the mass and charge of an electron are the same whatever be its source. Thus now it is scarcely too much to say that nearly all electrical phenomena are conditioned by the presence and motion of electrons. The current in a cable is a stream of electrons; a conductor is a body through which they move freely; an insulator checks their activity. The power that drives our motors comes from them; the light of the electric lamp, the heat that comes from an electric radiator, have their origin in these tiny particles; the plate current of the valve rectifier referred to above is a stream of electrons; when the grid is negatively electrified, it adds negative electrons to the stream; when it is positive, some of the electrons from the filament are stopped in their passage through its interstices to neutralise the positive electricity it possesses.

Electrical engineering in its many branches is closely bound up with the properties of an electron discovered by men whose sole object it was to advance natural knowledge. Nor is this all: for from the electron came X-rays, though this, perhaps, is scarcely the correct way of putting it, as J. J. Thomson's discovery really followed that of Röntgen. About 1894, physicists in many countries were experimenting with Crookes's cathode rays. A chance observation made by a skilled worker revealed the fact that the cathode rays produced an effect outside the tube in which they were generated. Röntgen in the autumn of 1895 was conducting an investigation with a vacuum tube wrapped in light-proof paper, and noted that a fluorescent screen of barium platino-cyanide lying near shone out when the tube was excited; if he placed opaque objects between the screen and the tube, shadows were cast on the screen, showing that rays, the X-rays, proceeded from the tube in straight lines; and it was quickly found that the rays penetrated substances opaque to light, the penetration depending on the density of the substance. There is no need to dwell on the results that have followed from this and their significance to engineers. X-rays can penetrate 4 to 5 mm. of lead, 12 mm. of tin, 75 mm. of carbon steel, 100 to 150 mm. of aluminium, and 300 to 400 mm. of wood. By their aid hidden cracks or faulty welds can be shown upon metal structures, while they have been employed for many industrial purposes, besides their use in surgery and medicine.

For some time the nature of X-rays was a mystery. Their rectilinear propagation and the absence of refraction when they fell obliquely on the surface of a medium other than air were difficult of explanation. Now it is known that they are produced by a very rapid change of motion of electrons. When the velocity of an electron is altered, an electro-magnetic wave is produced, and, starting from the electron, travels outward with the velocity of light. The frequency in this wave—in the number of vibrations per second produced—depends on the suddenness of the change of velocity of the electron. If this is very great, the frequency in the resulting wave is also very great. When a beam of cathode rays falls on the glass walls or on the anti-cathode of an X-ray bulb, the electrons are stopped almost instantaneously. Electro-magnetic rays of very high frequency—X-rays—are produced. Their wave-lengths are now known to lie between 12×10^{-8} cm. and $0·17 \times 10^{-8}$ cm. The wave-length of visible light is between 7700×10^{-8} cm. and 3600×10^{-8} cm., that of ultra-violet light lies between 3600×10^{-8} cm. and 200×10^{-8} cm., and it is to this minuteness of wave-length that the absence of refraction is due. In the hands of Sir William and Prof. W. L. Bragg, it has been the means of revealing the inner structure of materials in a manner which is of the utmost importance to engineers.

[6] One electro-magnetic unit is the charge transferred by 1 ampere circulating for 10 seconds.

Terrestrial Magnetism and the Orientation Faculty of Birds.

THE possible existence of a "magnetic sense" in animals has for long been a subject of speculation, and Lord Kelvin is numbered among those to whom the idea has proved attractive. No direct evidence in its favour has ever been obtained; but, on the other hand, there is no actual proof that some form of physiological sensibility to the phenomena of terrestrial magnetism may not exist and be a factor in that mysterious power of geographical orientation which is displayed by many animals and by primitive man.

The idea has often been invoked in the case of the especially remarkable powers of orientation which are possessed by migratory birds and by homing pigeons, and it is to be feared that much loose talk has at times been indulged in on this particular point. A recent author (F. Cathelin, "Les Migrations des Oiseaux," Paris, 1920) has gone so far as to propound a theory of migration which dispenses with instinctive behaviour in favour of "galvanotropism," and reduces birds to the status of mere automata acting under the compulsion of "des grands courants aériens électro-magnétiques équinoxiaux." Unfortunately for his argument, it is based on a conception of migration which is not consistent with many of the established facts, and it presupposes the existence of physical phenomena as to which the physicists are silent. Nor is its credibility increased by the absence of any suggestion as to a possible physiological mechanism linking the supposed physical causes to the alleged biological effects. At the best it is one of those "explanations" which call for more explaining than the original phenomena.

In these circumstances one welcomes a serious attempt, by a biologist and a physicist in collaboration, to set forth the possibilities of the case. This has been done by Dr. Rochon-Duvigneaud and Prof. Ch. Maurain (*La Nature*, 1923, 232) in respect of homing pigeons. In this paper Dr. Rochon-Duvigneaud begins by stating the biological data, and Prof. Maurain, who is director of the Institute of Terrestrial Physics in Paris, follows with a discussion of the physical facts, particularly those of terrestrial magnetism, which might be relevant. Prof. Maurain confines himself to a statement of apparent possibilities; he holds none of them as proved, and he urges the need for experimental inquiry. Whether his tentative hypothesis is sufficiently plausible from a biological point of view to constitute a *prima facie* case for further research on these lines, however, is perhaps open to doubt.

Prof. Maurain's suggestion may be stated as follows: The magnetic declination (angle of magnetic needle's lateral deviation from the geographical meridian) and the magnetic dip or inclination (angle of needle's vertical deviation from the horizontal plane) both vary from place to place over the surface of the globe. The periodical variations at any given place, and the irregular disturbances which also occur, are small in proportion to the otherwise constant geographical differences. Roughly speaking, therefore, every locality has its characteristic declination and dip. If lines be drawn through the places having the same declination, and other lines through the places having the same dip, these lines are (in Europe) roughly at right angles to each other. The lines thus serve as co-ordinates, which fix the position of any given locality like lines of longitude and latitude. Moreover, the declination and dip increase or decrease progressively as distance from a given locality is increased, except along those lines where one or other factor remains constant. So much is a matter of common knowledge.

It has then to be supposed that the pigeons are sensitive to changes in declination and dip, and indeed simultaneously sensitive to each factor independently of the other, and that when removed to a new locality the birds have a natural tendency, so to speak, to seek their own magnetic level. If a pigeon be removed to another place having the same declination but a greater (or less) dip, it would fly along the line of equal declination in the direction of decreasing (or increasing) dip. Similarly, if removed to a place having the same dip, it would follow the direction in which the declination changes towards the amount found at the home locality. Again, in the more general case of a bird removed to a place where both declination and dip are different, it would be affected by both factors and its homeward path would be the resultant of the two tendencies. (It is noted that there is no question of remembering the magnetic changes experienced on the outward journey, as a bird removed by a circuitous route will find a direct path home.)

Ornithologists will be grateful to the physicist for the statement of a possible case, but they will regret that Prof. Maurain has confined his argument to the relatively short journeys performed by homing pigeons and to the magnetic phenomena as they exist in Europe (for it is not in every part of the world that the lines of equal declination and of equal dip run at right angles to each other, and that there is only one point at which a given pair of values for these factors is to be found). They would have liked to see a case similarly stated in respect of the migrations of, say, swallows from South Africa to England (cf. NATURE, March 16, 1922, p. 346), over an area in which more complicated changes in terrestrial magnetism have to be reckoned with. Dr. Cathelin notwithstanding ("Le retour au nid reste donc pour nous une des grandes hérésies ornithologiques"), an ever-increasing volume of records of marked birds shows that swallows and others commonly perform very accurate feats of "homing" from great distances.

Returning to homing pigeons, however, we may examine the argument more closely. The physical phenomena exist, and a remarkable power of orientation is undoubtedly involved in homing; can a connexion be traced between them? The most serious objection seems to be the entire absence of any evidence of sensibility to magnetism on the part of birds or other animals; and without this physiological link speculation must needs be barren. Kelvin got negative results from his experiment of subjecting the human head to the influence of a powerful magnetic field; Du Bois observed no effect on protozoa; and the writers of the paper under discussion have similarly failed with pigeons. Within a limited field, it must be remembered, the strong electro-magnets used in such experiments are very many times more powerful than terrestrial magnetism: yet for Prof. Maurain's hypothesis we must suppose that birds are sensitive not only to minute changes in terrestrial magnetism, but also to changes in two of its factors separately. It does not seem, therefore, that the theory can be regarded as a promising one.

Prof. Maurain apparently holds, nevertheless, that there is a good case for further investigation, and he discusses in some detail the conditions necessary for an experiment on pigeons during their actual homing flight. It is not, of course, possible to interfere with terrestrial magnetism by means of artificial magnets over an area of any size, although it is admitted that pigeons find their way back as easily to lofts in great cities, where electric cables and the like cause an appreciable disturbance, as to lofts in the open country. The pigeon might be made to carry a small magnet and thus be kept within its field, but negative results would not be considered altogether convincing, because the amount of interference with terrestrial magnetism would be constant throughout; whether a portable apparatus giving varying magnetic effects could be designed is not discussed. Our author considers that the only possibility is to rear pigeons in a confined space within a powerful and varying magnetic field, and to remove them eventually to a distance under similar conditions. On being liberated for flight the birds would, for the first time in their lives, come under the undisturbed influence of terrestrial magnetism, and in these circumstances it should, by hypothesis, be useless to them as an aid to homing. We may hope that the experiment will be attempted, but until and unless some positive indications are obtained we are justified in remaining more than a little sceptical as to the existence of a "magnetic sense." A. L. T.

New General Anæsthetics.

THREE-QUARTERS of a century ago the era of surgical anæsthesia was suddenly and unexpectedly opened with ether, chloroform, and nitrous oxide. The relative importance of these three in surgery has varied at different times, but none of the many substitutes suggested has secured a permanent footing in surgery, although several have had a shorter or longer vogue.

The paramount consideration in the choice of an anæsthetic is safety, and it is recognised that this may be conduced to by avoiding the prolonged unconsciousness of ether and chloroform. This has led to the increased prominence of nitrous oxide in recent years; but while this induces rapid and safe anæsthesia, it can be used for ordinary surgical work only with difficulty, owing to the cumbrous apparatus necessary.

Within the last few weeks two new anæsthetics have made their appearance in acetylene and ethylene, each diluted with oxygen; the first hails from the pharmacological laboratory of Prof. Straub of Freiburg, the second from Drs. Luckhardt and Carter of the University of Chicago. Each is said to induce anæsthesia without preliminary discomfort and with rapid recovery afterwards. This short duration of the action is similar to that of nitrous oxide and ethyl chloride, and is associated with the rapid absorption and elimination of the anæsthetics owing to their volatility; for all four are gases at ordinary temperature and pressure.

The new anæsthetics appear to be more powerful than nitrous oxide, however, for they are efficient when mixed with oxygen, and the anæsthesia can therefore be maintained continuously without danger of asphyxia. On the other hand, they are devoid of the halogen component of ethyl chloride, which lends it an effect on the heart which is absent in the unsubstituted molecule. The introduction of these unsaturated hydrocarbons is of practical and also theoretical interest. A higher homologue of ethylene was early suggested by Snow (1853) as an anæsthetic in amylene, and more recently a purer preparation of analogous composition had some success under the name of pental. Ethylene and acetylene have to be kept under high pressure, and it may be that this inconvenience may militate against their more general use, even if the favourable reports given by their sponsors are confirmed by further experience.

Obituary.

Mrs. Ludwig Mond.

ALL friends of Mrs. Mond, widow of Dr. Ludwig Mond, will mourn her death, on May 16, at The Poplars, Avenue Road, Regent's Park, of which she had so long been the attractive figure and ornament.

Those who knew Dr. Mond intimately enough to visit his home could never think of him alone but necessarily associated him with his wife: they were an inseparable couple in thought and, in all their social interactions, as wonderfully adjusted as were the two salts he caused to interact in the great works his genius created. This came from the fact of their early intimate association.

They were first cousins; her mother was his loving counsellor when he was a youth; and they became secretly engaged before he was of age, when she was a girl of thirteen at school. Up to their marriage, after he was established in England, they maintained a constant correspondence of a most intimate character, which it has been my privilege to see in large part; it affords the most striking picture possible of the charm and simplicity of German life in those early days. Mrs. Mond's letters from the beginning show an extraordinary maturity and sobriety of judgment. It is clear that Dr. Mond's later æsthetic development was greatly due to the foundation laid during this period, mainly through the influence his wife exerted on him. In their married life she cast a spell upon all his friends which greatly added to his influence. Her ability is well brought out by Mr. T. P. O'Connor, M.P., in the *Sunday Times*, in the following few lines:

"Mrs. Mond, his wife, struck me as being almost as big a mind as her husband. In a few sentences, describing the difference between the Gothic and the Renaissance types of architecture—especially of the architecture of the cathedral—I got a clearer idea of the two ideals than I could have learned from a dozen books."

By Mrs. Mond's death, the nation comes into possession of Dr. Mond's great gift of Italian pictures and the Royal Society receives his bequest of 50,000*l*. It is a sad fact that the enterprise in which Dr. Mond was so particularly interested—the International Catalogue of Scientific Literature—the promotion of which, I know, was specially in his thoughts when he made the bequest, has been allowed to lapse almost at the moment his gift becomes fruitful. He may be said to have been the main promoter of the Catalogue and the greatest believer in its ultimate value to the scientific worker. He would have deplored nothing more than its abandonment at the time when development of the spirit of international co-operation is so imperative a need.

Unfortunately, we have lost the broad outlook which characterised Mond and his generation; Michael Foster seems to have been its last exponent in the Royal Society, the last who dared to cultivate enthusiasm. Apparently, we are no longer able to maintain continuity of thought and action; nor, when we have done well, to realise the importance of our work and take pride in carrying it to completion. We prate of science but the true spirit of scientific method is no longer in us. H. E. A.

Current Topics and Events.

By the death of Mrs. Mond, widow of Dr. Ludwig Mond, which occurred on May 16, the Royal Society becomes the beneficiary, under Dr. Mond's will, of a considerable sum of money in furtherance of scientific objects. Dr. Mond, as is well known, was a distinguished chemical technologist. He worked under Kolbe at Marburg, later under Bunsen at Heidelberg, finally becoming domiciled in England, where he secured the friendship of the leaders of British science, as also of many persons in literary and artistic circles. He was elected a fellow of the Royal Society in 1891, and died in 1909. The provisions of his will relating to gifts to science provided for the payment to the Royal Society, free of duty, of 50,000*l.*, the income to be employed in the endowment of research in natural science, more particularly, but not exclusively, in chemistry and physics, by means of rewards for new discoveries and pecuniary assistance (including scholarships) to those pursuing scientific investigations, and in supplying apparatus and appliances for laboratories and observatories, and in such other manner as the Royal Society should decide to be best calculated to promote scientific research. There was also the proviso that the Royal Society's council might allocate amounts for the publication and circulation of reports and papers communicated, and assist the preparation and publication of catalogues and indexes of scientific literature which the Society might have engaged in or might undertake in the future. To the University of Heidelberg a like sum was left, and for kindred purposes. Certain financial contingencies entailed that four years might elapse after Mrs. Mond's decease before these two bodies entered upon absolute ownership; notwithstanding, the legacies were to carry 4 per cent. interest per annum until paid up. It may be recalled that at the Royal Society's anniversary meeting of 1910 the then president referred to Dr. Mond in the following terms:—" The Royal Society has good cause to cherish his memory as that of a genial Fellow, who took an active interest in its affairs, affording it at all times the benefit of his business experience, and ever ready to aid financially any of its enterprises which seemed to him to stand in need of assistance. By his will also he has left a munificent benefaction whereby the Society will ultimately be enriched."

At the present time the phytopathological service seems to be exceptionally vigorous in the United States, owing largely to the forward policy adopted both by the Department of Agriculture at Washington and by the various agricultural colleges and experiment stations scattered throughout the different states. In *Phytopathology* for March last, the report of the fourth annual field meeting of the American Phytopathological Society makes very suggestive reading as to the range of activities of the American phytopathologist. The three earlier conferences had been devoted to potato, fruit, and cereals respectively; meeting this time in the important vegetable-growing region around Delaware and Philadelphia, the conference spent one day inspecting the sweet-potato storage house of the Johnson Potato Storage Company (with a storage capacity of 125,000 five-eighths bushel baskets), and the farms in the neighbourhood, where cantaloupes, asparagus, tomatoes, cow peas, soy beans, and especially sweet potatoes, were growing. The next day, in the New Jersey district, experiments upon the control of tomato disease, carried out by a commercial firm, trials of sweet-potato varieties for resistance to fusarium wilt, and cold-storage plants and orchards, together with official tests on fungicides, were examined. The last day was spent in the extensive "trucking sections," *i.e.* regions growing vegetables for the market, around Bustleton, where the Pennsylvania Agricultural Experiment Station has a research laboratory. Here experiments upon the control of celery leaf diseases, downy mildew of the Lima bean, lettuce drop and rhubarb crown rot were seen in progress. It is true that in Britain the plant pathologist and other agriculturists have discussed the problem of potato-growing and especially their diseases, under the auspices of the National Horticultural Society, but no opportunities for the exchange of ideas and the accumulation of experience are available in this country to British plant pathologists, such as are annually placed before some 60 to 70 phytopathologists by this field conference.

The value of the research laboratories now attached to many large firms was emphasised by Sir Richard Glazebrook in his "James Forrest" lecture to the Institution of Civil Engineers on May 4. The work of such laboratories is of necessity aimed at improving the products of the firm, but it is being realised more and more that for this purpose investigations in pure science are also essential. Probably the best-known engineering research laboratory controlled by an industrial firm is that of the General Electric Company at Schenectady. This laboratory has deliberately sought entirely new discoveries, new applications of materials, and new developments of electricity. From it have come the metalised carbon and the drawn-wire tungsten filament lamp, the nitrogen-filled high-efficiency lamp, the magnetite arc lamp, and the Coolidge X-ray tube. The development of each of these has involved investigations of great importance to pure science; Dr. Langmuir, of the G.E.C. laboratory, occupies one of the leading places among workers on the problem of the constitution of the atom. Other American laboratories are the Westinghouse Electric and Manufacturing laboratory and that of the Eastman Kodak Company; the work of the latter on light filters is well known, and has its bearing on the microphotographic work so important to engineers. There are few such great laboratories in England. But there are pioneers who recognised long ago the value of the great work which science can do for industry. Manganese steel was produced in 1882 from the laboratory of Sir Robert Hadfield, as the result of a scientific inquiry into the properties of alloys. The Brown-Firth laboratories of John Brown and Sons, and the laboratories of the Westinghouse works in Manchester have conducted and are carrying out valuable researches, and great things are looked for from the new laboratories of the General Electric Company at Wembley. The ideals which Mr. C. C. Paterson enunciated at the opening of the G.E.C. laboratory are high, and should lead to the advancement of scientific knowledge in many directions.

At a meeting of the Royal Society of Arts on May 16, a paper on "Industrial Lighting and the Prevention of Accidents" was read by Mr. L. Gaster. The early part of the lecture was devoted to a summary of progress in illuminants, after which statistics were quoted showing that inadequate lighting is a contributory cause of many industrial accidents, those arising from "persons falling" being a specially striking example of this relation. Apart from possible ill effects on the eye, great importance should be attached to the effect of unsatisfactory lighting conditions in causing industrial fatigue, and consequently ill-health, spoiled work, and diminished output. In the cotton, fine linen and silk industries it had been found that output was 5-12 per cent. less by artificial light than by daylight. A recent investigation of the National Institute of Industrial Psychology showed that by using a lamp giving four times the light of an ordinary miner's lamp the amount of coal produced was increased by more than 14 per cent. The paper, which was fully illustrated by lantern slides, including some striking views of the L.G.O. repair works taken by daylight and artificial light respectively, was largely devoted to an exposition of the various reports issued by the Departmental Committee on Lighting in Factories and Workshops. It was mentioned that a similar Committee has been appointed by the Ministry of Labour in France to deal with the subject, and that seven American States now possess codes of industrial lighting. Mr. Gaster expressed the hope that the new Factory Act will endorse the recommendations of the Departmental Committee, and that illumination will be ranked with heating and ventilation as an essential item in the interests of health, safety, and efficiency of work.

We have on several occasions referred with regret to the fact that no provision is made for a composite display of scientific discovery and achievement at the British Empire Exhibition to be held next year. In this connexion the following extract from the fourth annual report of the governors of the Imperial Mineral Resources Bureau is of interest: "The British Empire Exhibition authorities requested the Bureau to undertake the organisation of an exhibit illustrative of the mineral resources of the Empire, and the Governors set up a Committee which drew up a scheme for such an exhibit. Numerous meetings were held and the details of the exhibit worked out. We were subsequently informed that funds were not forthcoming from exhibition sources, and the Bureau then had to abandon the comprehensive scheme which they had elaborated for the illustration of the whole mineral wealth of the Empire."

A novel feature of the meeting of the British Association at Liverpool, on September 12-19, will be a scientific exhibition at which there will be exhibits of apparatus in connexion with each section of the Association, and others showing recent advances in applied science. The exhibition will be held in the buildings of the Central Technical Schools, Byrom Street, Liverpool, which have been allocated for this purpose by the Technical Education Committee of the Liverpool Corporation. The buildings are extensive and centrally situated, and the electrical and other facilities are admirably adapted for the purpose It is anticipated that all the leading manufacturers of scientific apparatus in the country will be represented. The exhibition will be open to members of the Association during the period of the meeting; but in view of the fact that it is the first of its kind, and will without doubt appeal to public interest in scientific achievement, it is intended to open the exhibition on September 10 and to keep it open until September 22, the public being admitted at a small charge.

The constitution and by-laws of the new Engineering Joint Council have just been published. This Council is defined as "an advisory body without executive powers." It was founded by the Institutions of Civil, Mechanical, and Electrical Engineers and Naval Architects, but it is anticipated also that other institutions will desire representation on the Joint Council. These are divided into Constituent Institutions and Affiliated Institutions. The latter may be transferred to the former group when the standard of their entrance examinations is sufficiently high and the number of their corporate members is sufficiently large. The Council will not initiate proposals, but will consider matters referred to it by the Council of any one of the constituent institutions. As the welfare and safety of the whole nation are largely dependent on the prosperity of the engineering industries, it was felt that they should have a larger share in the national councils. The Joint Council, therefore, has been founded to foster engineering interests and to be ready always to take immediate action in any national emergency, and it has started auspiciously. The various institutions have worked very harmoniously together, and further important developments may be expected.

The arrangements for the visit of Their Majesties the King and Queen to University College Hospital and University College, London, on May 31, are now approaching completion. As already announced, the ceremony is in connection with the great gift made in 1921 by the Rockefeller Foundation of New York for Medical Education. It will have two features, the laying of the foundation-stones of the new Obstetric Hospital and new Nurses' Home now being erected on sites adjacent to University College Hospital, and the opening of the new Anatomy Building which has already been erected in Gower Street. Their Majesties will arrive at 3.15 P.M., and the ceremony of laying the foundation-stones will take place in a pavilion to be erected in University Street. After the conclusion of the first part of the ceremony, Their Majesties will proceed across Gower Street, and the King will declare open the Anatomy Building. The gift of the Rockefeller Foundation for these important medical objects is a sum of 400,000*l.* for the erection of the buildings in connexion with University College Hospital and Medical School; 435,000*l.* for an Endowment Fund for the improvement of medical teaching and for the purpose of developing general medical education and research on modern lines; 370,000*l.* for the erection and endowment of the anatomy buildings at University College, including the extension of the physiology and pharmacology buildings. The total benefaction thus amounts to 1,205,000*l.*, and is probably the largest single benefaction ever provided in this country for educational purposes.

A PRELIMINARY announcement regarding the general discussion on the electronic theory of valency arranged by the Faraday Society, to be held at Cambridge on July 13-14, has been issued. Prof. G. N. Lewis will open the proceedings on the Friday afternoon with a general introductory address, and he will probably be followed by Mr. R. H. Fowler, who will contribute a paper intended to open discussion on the physical and inorganic side of the subject. Among those expected to speak are Sir J. J. Thomson, who will be in the chair, Sir Ernest Rutherford, Sir William Bragg, and Prof. W. L. Bragg. The Saturday morning session will be devoted chiefly to applications of the theory in organic chemistry. Sir Robert Robertson, president of the Society, will preside, and opening papers will be given by Prof. T. M. Lowry and Dr. N. V. Sidgwick. Among those expected to speak are Prof. W. A. Noyes, Sir William Pope, Prof. A. Lapworth, Prof. I. M. Heilbron, Dr. W. H. Mills, Prof. J. F. Thorpe, and Prof. R. Robinson. On the Friday evening a complimentary dinner will be given to Profs. Lewis and Noyes and other guests at Trinity Hall. Arrangements are being made to accommodate those attending the meeting in one or other of the Colleges, and it will be possible to include a limited number of non-members of the Society. Particulars may be had from the Secretary of the Faraday Society, 10 Essex Street, London, W.C.2, to whom applications should be made at once.

THE annual visitation of the Royal Observatory, Greenwich, will be held on Saturday, June 2.

THE annual general meeting of the Institute of Physics will be held in the rooms of the Royal Society, Burlington House, on Wednesday, May 30, at 5.30 P.M. In the course of his presidential address, Sir Joseph Thomson, who has recently returned from the United States, will refer to the position of industrial research there in physics.

AT the meeting of the National Academy of Sciences held in Washington on April 25, the following officers were elected: *President*, Prof. A. A. Michelson; *Vice-President*, Dr. J. C. Merriam; *Secretary*, Dr. David White; *Foreign Secretary*, Prof. R. A. Millikan; *Treasurer*, Dr. F. L. Ransome.

THE U.S. National Academy of Sciences has made the following awards: the Comstock prize to Prof. William Duane, professor of bio-physics in Harvard University, in recognition of his researches on X-rays, and the Mary Clark Thompson gold medal to Dr. Emmanuel de Margerie, director of the Geological Survey of Alsace and Lorraine.

AT the Royal Institution on Friday evening, June 15, Sir Ernest Rutherford will give his postponed discourse on "The Life History of an Alpha Particle of Radium," and his concluding lecture on "Atomic Projectiles" will be delivered on Saturday afternoon, June 16.

AT the annual general meeting of the Linnean Society of New South Wales, held on March 28, the following officers were elected: *President*: Mr. A. F. Basset Hull. *Members of Council* (to fill six vacancies): Mr. E. C. Andrews, Mr. J. H. Campbell, Mr. H. J. Carter, Sir T. W. E. David, Prof. W. A. Haswell, and Prof. A. A. Lawson. *Auditor*: Mr. F. H. Rayment.

PROF. J. P. HILL, Jodrell professor of zoology and comparative anatomy in the University of London, and Prof. J. T. Wilson, professor of anatomy in the University of Cambridge and formerly Challis professor of anatomy in the University of Sydney, have been elected honorary members of the Linnean Society of New South Wales.

AT the annual general meeting of the Institution of Electrical Engineers to be held on Thursday, May 31, there will be presented to the Institution: (1) An oil painting of the late Dr. Silvanus Thompson (presented by Mrs. Thompson); Dr. Thompson's library (presented by a number of members of the Institution and others); and (2) a bronze bust of Dr. Thompson, by Mr. Gilbert Bayes (presented by the Finsbury Technical College Old Students' Association).

NEWS has reached this country of the family of the late General Rykatchef, who was director of the Russian Meteorological and Magnetic Service until shortly before the War. General Rykatchef died on April 1, 1919, his wife on November 22 of the same year. The last survivor of three sons died on February 24, 1920. A son-in-law perished on July 6, 1919, leaving five young children. They, with their mother and her sister, who is well known to meteorologists and magneticians as her father's constant companion on his international journeys, are the only survivors of a once large family.

THE following foreign members have been elected by the Geological Society: Prof. L. Cayeux, Paris; Prof. J. M. Clarke, director of the New York State Museum, Albany (New York); Prof. H. Douvillé, Paris; and Prof. W. Lindgren, Massachusetts Institute of Technology, Boston, Mass. Foreign correspondents have also been elected as follows: Prof. E. Argand, University of Neuchâtel; Prof. L. W. Collet, University of Geneva; Prof. R. A. Daly, Cambridge (Mass.); Prof. G. Delépine, Lille; Prof. P. Fourmarier, Liège; Prof. V. M. Goldschmidt, Universitets Mineralogisk

Institut, Christiania; Prof. T. G. Halle, Naturhistorisk Riksmuseum, Stockholm; Prof. J. F. Kemp, Columbia University, New York City; Prof. C. F. Kolderup, University of Bergen; Prof. C. I. Lisson, Escuela de Ingenieros, Lima; Prof. G. A. F. Molengraaff, Delft; Dr. A. Rénier, Directeur du Service Géologique de Belgique; Prof. P. Termier, Directeur des Services de la Carte Géologique de France; and Dr. F. E. Wright, Geophysical Laboratory, Washington, D.C.

The floral ballet, composed by Dr. G. Rudorf, and conducted by him at the Alexandra Palace on May 19, in aid of the Royal Northern Hospital, as announced in last week's issue, p. 681, proved very delightful music. Specially written for a choreographic flower-story arranged by Mrs. A. E. Ormen Sperring for her pupils, the work, which lasted three-quarters of an hour, contains a great variety of melodic material. In his professional capacity as a chemist, and as collaborator with Sir William Ramsay in a treatise on the rare gases, Dr. Rudorf is well known; and he is to be congratulated upon the skill he has shown in the production of a musical work of real merit.

Mr. F. Edwards, 83 High Street, Marylebone, W.1, has just circulated a catalogue (No. 443) of some 1100 books and serials relating to anthropology, folklore, archæology, etc., some of which formerly belonged to Prof. Huxley. We notice that Mr. Edwards has also for disposal a small collection of Australian native weapons and implements of the period 1840–50, from the collection of Mr. S. T. Gill, an Australian artist.

Our Astronomical Column.

The Theory of Jupiter's Satellites.—Prof. de Sitter, of Leyden, lecturing on this subject at the University of Manchester on May 9, emphasised the interest attaching to the theory of the motion of the four Galilean satellites (to which his remarks were confined), because they illustrate the more important features in the theory of the motion of the planets round the sun, but with a time-scale reduced in a ratio of about 3000 to 1. The theory can thus be checked by observations extending over a period of a few decades, but the difficulty of deriving from the observations the masses of the satellites, and the elements of their orbits, is greatly enhanced by the intercommensurability of the periods of the three inner satellites. Though the tables published by Prof. Sampson a few years ago represented a great advance at the time of their appearance, they still require to be confirmed and extended by other methods. The commensurability of the periods renders the ordinary expressions found in celestial mechanics too slowly convergent, and necessitates the search for a new solution, starting from a periodic solution as the first approximation. The commensurability also makes the observations of eclipses and transits of the satellites less satisfactory than usual for the determination of the elements of the system. In order to counter these difficulties, such observations have to be extended over a whole period of revolution of Jupiter (12 years) and supplemented by photographs taken at selected epochs before and after each opposition. Such observations have been made at Greenwich, the Cape, and Johannesburg, and are now in Prof. de Sitter's hands for discussion. The discussion is well in hand, and the results promise to be satisfactory.

Unknown Lines in Stellar Spectra.—To all spectroscopists the paper by Mr. F. E. Baxandall on "Lines of Unknown Origin in various Celestial Spectra" (Mon. Not. R.A.S., vol. 83, p. 166) will be very welcome. Mr. Baxandall's skill in deciphering spectra is well known, so the results here collected are of special value. In the year 1910 Sir Norman Lockyer published a list of fairly prominent lines for which no satisfactory origins had been found, but since then many of them have been run to earth, notably the line at λ 4688, which is now known to be due to ionised helium, and the ζ Puppis lines due to the same element. Eliminating these lines from the list of unknowns, Mr. Baxandall gives rather a formidable table containing about 130 lines still unknown. The wave-lengths of these lines have all been observed in some source of celestial light, and the table indicates which particular source, whether sun, star, corona, nebula, and so on, in which they have been observed. The paper is accompanied by copious notes and references.

850 New Nebulæ.—Dr. Harlow Shapley, in the Harvard College Observatory Bulletin, No. 784, points out that photographs made with the Bruce telescope at Arequipa, Peru, supplement the data for nebulæ not easily reached from northern observatories. On a photograph made on September 19, 1922, with an exposure of six hours, centred on R.A. $22^h\ 40^m$, Dec. $-45°$, Dr. Shapley has found 850 new nebulæ. On the following night another exposure was made, this time for two hours only, which showed all objects brighter than the eighteenth magnitude. He points out that these new nebulæ are not of the nature of the faint irregular nebulous wisps frequently found in the vicinity of bright spirals, but are distinct nebulæ, the fainter ones almost exclusively oval or circular in form, distributed over an area of about thirty square degrees. It is interesting to note that only three nebulæ of the N.G.C. fall within this region and three from the second Index Catalogue. The brighter nebulæ are, almost without exception, elongated or show spiral structure, while the fainter ones appear largely to be globular. The shape of these latter, as Dr. Shapley points out, may be due simply to under-exposure of the plate, since many of the bright nebulæ, on a short exposure, lose the faint extensions that reveal their truly elongated shape. The interesting remark is made that on many parts of this plate at the eighteenth magnitude, the nebulæ are more numerous than the stars.

The Astronomical Society of South Africa.—A local astronomical society was formed at Capetown ten years ago; this has now been extended to include the Johannesburg society, and the first Journal of the combined body was published in February. The inaugural presidential address by Dr. Hough deals with the tides in a clear and interesting manner, explaining methods of tidal analysis and prediction, and giving an outline of Sir G. Darwin's theory of the development of the earth-moon system by tidal evolution. The society has been especially active in comet and variable star work; the former is fully dealt with in the Journal.

Research Items.

INDUSTRIAL PSYCHOLOGY AND COAL MINING.—In the Journal of the National Institute of Industrial Psychology (vol. 1, No. 6), a colliery director discusses the application of industrial psychology to coal mining. He points out that hitherto it has been taken for granted that in some wonderful way the art of coal mining is handed on from old collier to young collier and from father to son. Again, the very vital importance of the industry to the country has made it the battle-ground of conflicting interests, so that employers and trade union officials make many statements about the needs and desires of the workers, statements which are not infrequently mutually incompatible. Seeing that there is so much bias, the writer suggests that the proper person to obtain actual facts is the man of science. He therefore advocates a considerable development of the small-scale investigation done already by the Institute for one firm, so that methods of training and instruction, general conditions of work, and allied problems should be studied and the best methods discovered. Just as it has been found necessary to study methods and training for sport, so a similar study would, in the writer's opinion, be found helpful in coal mining. If industrial psychology can show how to increase output and with it wages, and yet leave the coal-getter less fatigued, it will do more for the general trade of the country than has been dreamt of.

CHEMISTRY IN MEDIEVAL ISLAM.—In the issue of *Chemistry and Industry* for April 20, Mr. E. J. Holmyard contributes an interesting article on this subject. He points out that no serious attempt has hitherto been made to study adequately the large number of Arabic chemical treatises which have come down to us—and he might have added that, in spite of this, the most dogmatic assertions about some aspects of the problem are still put forward with surprising confidence by recent writers on the history of chemistry. Chemistry was taken over by the savants of Islam from the Greek school at Alexandria about the 7th century A.D., and for five or six hundred years—namely, to the 12th century—it was almost a monopoly with them. The most famous of its votaries was Geber, or Jabir ibn Hayyan, probably born at Harran in Mesopotamia, who attained a position of eminence under the Caliph Harun al-Raschid (A.D. 786–808). The identity of Jabir with the Geber of the Latin works, which became known to Europe about A.D. 1300, although it is now denied by most writers, is, according to Mr. Holmyard, very probable, and he has important new material in this field. The leanings to mysticism which Geber and other chemists show is probably to be attributed to Neo-Platonic influences, which also tinged their chemical views. A belief in astrology, and in the connexion between planets and metals, was shared by all thinking men of the time, but played a relatively unimportant part in the chemistry of Islam. Scepticism as to the possibilities of transmutation also appeared at an early date. Mr. Holmyard gives many further details, and his paper is one which throws much light on this interesting period in the history of chemistry.

DIFFICULT AND DELINQUENT CHILDREN.—In *Psyche* (vol. ii. No. 4) Dr. R. G. Gordon discusses the problems concerned with the difficult and delinquent child. Every teacher and doctor has come across the child who does not fit in with the others, who, in spite of all efforts on the part of those responsible, persists in various forms of misbehaviour, frequently of a futile and useless character, and finally becomes ungovernable. The problem should be faced by trying to find out why such a child is difficult, and for this purpose it should be possible for every suspected child to be examined, in the first place, physically, as it is known how such factors as abnormalities in the secretions of the endocrine glands, eye strain, etc., affect mental development; then his intelligence should be tested, and thirdly, his reaction to life should be investigated. It must be borne in mind that lack of intelligence is by no means an invariable concomitant of delinquent behaviour. The writer hopes that eventually the State will provide the means for such work, but he realises that the time is not yet. In conclusion, he puts in a timely warning that the proper selection of workers for such investigation is of vital importance.

TREATMENT OF ELECTRIC SHOCK.—Sir Bernard Spilsbury and other writers discuss the condition of individuals who have been subjected to electric shock, in *Archives of Radiology and Electrotherapy*, No. 272, March 1923, p. 316. The pathological changes in the tissues in fatal cases are generally very slight—burning at the point of entrance and exit of the current and hæmorrhages beneath or in the skin and into the muscles. Although some cases may die from paralysis of the heart, many are cases of "suspended animation" due to sensory stimulation causing paralysis of respiration. In many of the last-named class the immediate application of artificial respiration will resuscitate the unconscious and apparently dead with complete recovery.

NERVES OF THE FINGERS.—In the *Journal of Anatomy* (vol. lvii., Part III., April 1923) Prof. J. S. B. Stopford, of the University of Manchester, has published a short note on the distribution and function of the nerves to the fingers. The paper is of exceptional interest and importance, because it gives a new orientation to the results of the last twenty years' researches on sensation and the interpretation of the effects of nerve injuries. With the object of settling this difficult problem once for all, Dr. Henry Head submitted himself to experiment in 1903, and had two nerves in his forearm cut across, so as to study the process of recovery of sensation. The nerves selected for this test were supposed to be distributed only to the skin, and Dr. Head assumed that when they were cut the nerves concerned with deep sensibility would remain intact. Prof. Stopford now finds that the nerves in question are not purely cutaneous, but also supply joints and some of the subcutaneous tissues. Hence the interpretation of Dr. Head's classical experiment and the far-reaching generalisations based upon it need to be re-examined in the light of these anatomical facts, which are doubly important because their reality has been established by an investigator of rare insight, who has a sympathetic understanding of Dr. Head's methods and results.

LINKED CHARACTERS IN THE MILLIONS FISH.—In a continuation of his investigations on the millions fish (*Lebistes reticulatus*), Dr. O. Winge (*Comptes rendus trav. Lab. Carlsberg*, vol. 14, No. 20) obtained a fish with a new factor for elongated caudal fin. This factor shows ordinary sex-linked inheritance, and is therefore located in the X-chromosome. In crossing experiments there is evidence that the factor may become transferred from the X- to the Y-chromosome by crossing over. It then shows male-to-male inheritance, as is the case with several spot characters in Lebistes. Later it may cross over again to the X, and so the manner of its inheritance oscillates irregularly between ordinary sex-linked and exclusively male-to-male transmission. This furnishes further evidence of the presence of active factors in the Y-chromosome of fishes. Some of the other evidence indicates that a localised sex factor is concerned in sex determination.

Peculiar Polish Wheat Cross.—In crosses between Polish and Kubanka wheat, Mr. F. L. Engledow (*Journ. Genetics*, vol. 13, No. 1) has studied the inheritance of length of glume, the respective parental lengths being about 12 mm. and 31 mm. The F_1 generation was intermediate, while in F_2 the three types could be classified by eye and approximated in numbers to the 1 : 2 : 1 ratio expected for a monohybrid difference. The segregated types bred true in later generations, while the intermediate type continued to split. The peculiarity was observed, however, that the Polish type segregated in F_2 had a mean glume length which had shifted from 31 to 24·6 mm., and this shift was maintained in later generations. The nature of this permanent modification in a character through crossing is discussed, and it is pointed out that a multiple factor hypothesis of size inheritance is insufficient to account for the results. The same phenomenon has been observed in other wheat crosses, but a complete explanation is not at hand. Perhaps the measurement of all glume lengths on each individual might aid in the analysis.

"Big Bud" of Black Currant.—This disease, caused by the currant gall mite, is widespread throughout Great Britain, and attacks and destroys black currant bushes. Hitherto no remedy has been discovered. In the orchard of the Crichton Royal Institution, Dumfries (a mental hospital), with 427 bushes, the following treatment (eighty-third annual report for the year 1922, Crichton Royal Institution, Dumfries) has been tried: The ground round the bushes was completely covered with straw and dead branches, which were then ignited (March 28, 1922). The scorched branches of the bushes were then cut off to within six inches of the ground, fresh straw was put on, and the whole again burnt. So far the treatment has been a success, for (1) less than 10 per cent. of the bushes have been lost, and (2) fully 90 per cent. have made a good recovery, showing 2-3 feet growth of healthy wood, with flower buds, giving promise of a half-crop the following (this) year, and with no indication of the mite at the end of 1922.

Date Palms of Iraq.—The Agricultural Directorate, Ministry of Interior, Iraq, has issued the third memoir of a series upon dates and date cultivation of the Iraq. In the memoir, V. H. W. Dowson briefly describes some of the better known varieties of the female palms of the Iraq and the dates they produce; the earlier memoirs have dealt with the habit, cultivation, and yield of the palms. Some of these varieties differ markedly in habit of growth and in average yield of produce, and the dates are by no means all the same, differing probably as much to the expert observer as do the different apples displayed in the shop window to the average English buyer, to whom all dates are very much alike. It is interesting, for example, to learn that the Ista-amran palm, forming some 45 per cent. of the palm population of the Shatt Al' Arab, produces a date which the Arab would class among the "hot," *i.e.* relatively indigestible dates. This palm gives relatively low yields, and yet probably one-third of the dates exported from Basrah are of this variety! Obviously, with attention turned to varieties, their quality and yield, there are great possibilities before the date industry, Iraq containing, it is estimated, some thirty million date palms; at present, the author reports, the demand for Iraq dates is only increasing in the United States. Prepared originally for the purposes of the Revenue Department of the Iraq, this memoir is a tribute to the industry of a recently constituted Administration and to its author, who confesses that its preparation has been rather a recreation than a labour, "because the date palm is so interwoven into the history, literature, and life of the Arab race."

A Causal Organism of Nasal Polypus.—In his memoir on *Rhinosporidium Seeberi* (Trans. Royal Soc., Edinburgh, vol. liii. part ii., No. 16), Prof. J. H. Ashworth has accomplished a notable piece of work, and one which forms a valuable contribution to medical biology. This remarkable organism, hitherto placed among the Sporozoa but regarded by Prof. Ashworth as a unicellular fungus, probably belonging to the Chytridineæ, is responsible for the development of a form of nasal polypus in human beings. Fortunately, it appears to be rare, at any rate among Europeans, and its geographical distribution is peculiar, including India, Ceylon, Argentina, and Tennessee, U.S.A. (one case). Prof. Ashworth was able to study the organism in the case of an Indian medical student at Edinburgh, and gives a detailed and beautifully illustrated account of the life-history. Attempts to cultivate the parasite in other animals or *in vitro* have been unsuccessful, and the method of infection is unknown.

The Devonian Formation in Australia.—Dr. W. N. Benson's "Materials for the study of the Devonian Palæontology of Australia" (Rec. Geol. Surv. New S. Wales, vol. x. pt. 2) is a memoir that will be much appreciated by geological students. It begins with an historical introduction in which the author sketches the progress in discovery of the Devonian rocks of Australia and their separation from the Silurian with which they had been formerly associated. The rocks and their contents of the several faunal provinces are next described as well as the distribution of the Australian Devonian fauna. There is also a chapter on Middle Devonian vulcanicity. An excellent bibliography and a useful register of the fossil localities follow, but what will prove of most use to the general student is the very full census and index of both fauna and flora, which forms half of the memoir and includes references to close on two hundred genera.

Upper Cretaceous Dinosauria from Alberta.—From among a collection of fossil vertebrates in the University of Alberta, obtained from Upper Cretaceous beds (Belly River formation) of the Red Deer River, C. W. Gilmore has singled out and describes, with excellent figures, some exceedingly interesting Dinosaurs (*Canadian Field Naturalist*, vol. xxxvii., No. 3). *Corythosaurus excavatus*, n.sp., is the second species of a genus the skull of which in its general outline recalls that of a bird rather than a reptile. In the case of this Dinosaur, however, the beak portion of the skull is formed by the premaxillaries, the entire upper and posterior portion of the crest being occupied by the nasal bones. Quite other in aspect is the skull of all the Upper Cretaceous armoured Dinosaurs: in them it is greatly depressed and has a broadly rounded muzzle. A well-preserved skull and right ramus, which the author tentatively refers to *Europlocephalus tutus*, Lambe, has afforded him the opportunity of contributing to the knowledge of the cranium of this group, for with the exception of the type of *Panoplosaurus mirus*, Lambe, only unsatisfactory fragments have hitherto been available. The author further directs attention to some features in the cranial structure of a specimen of Eoceratops from the same district, as well as to the first occurrence in the Belly River formation of a lacertian reptile, as evinced by the discovery of a dorsal vertebra bearing a striking resemblance in size and form to those of the genus Saniwa.

METEOROLOGY OF THE GULF OF BOTHNIA.—Several papers dealing with the meteorology of the Gulf of Bothnia and the northern part of Sweden have lately appeared. In "Ström och Vindobservationer vid Fyrskeppen" (Havsforsknings Institutets, No. 13, 1922), Mr. G. Granqvist records the wind direction and force at certain Finnish lightships, four in the Gulf of Finland and seven in the Gulf of Bothnia, during 1921. The records are of varying lengths of time, in most cases from June to November or December, but in two cases for January also. Observations were taken three times daily. In Statens Meteorologisk-Hydrografiska Anstalt, i. No. 4 (Stockholm, 1922), Dr. C. J. Ostman has a paper on "Recherches sur les grands vents près de la côte suédoise du Golfe de Botnie." The observations deal with the winds above force 7 on the Beaufort scale in eleven lighthouses and lightships. As a rule, the records are for the years 1907–1921, and cover the twelve months. The paper contains a discussion of the direction and nature of the depressions which influence the Gulf. The meteorological observations taken at the Swedish station at Abisko in Lapland during the year 1921 are published (Abisko Naturvetenskapliga Station, Stockholm, 1923). The hourly data are given *in extenso* with the legends of the tables in both Swedish and French. They include records of the water temperature in Lake Torneträsk.

RADIO IN RELATION TO WEATHER OBSERVATIONS.—Weather reports by wireless telegraphy and by the radiophone as received and disseminated in the United States from the beginning of this century to the present date are dealt with by Mr. E. B. Calvert of the U.S. Weather Bureau in the U.S. *Monthly Weather Review* for January. The history of the initiation and the development of the radio service is full of interest, and is dealt with from the year 1895, when Marconi commenced his investigations in wireless telegraphy, until the inauguration of radiophone weather broadcasting through the United States in February last. The Weather Bureau was the pioneer of all agencies of the U.S. Government in investigations and experiments in wireless telegraphy. It is stated by the author that in his opinion meteorology will advance hand in hand with radio, and that there must be close and undisturbed contact between the agencies engaged in meteorological and radio activities. Meteorology is essentially an international science, and weather has no national allegiance. Weather conditions prevailing in one country to-day may affect another to-morrow, or perhaps a week hence. The author is very strongly impressed with the importance of exchange of meteorological reports between different countries and especially among the nations in the Northern Hemisphere, in which radio must play a large and important part. Daily weather forecasts and storm warnings for all interested in agriculture ashore and for all vessels afloat in the open ocean and elsewhere have now become the common property of all. Mention is made of the forecasting demonstrated by the French training-ship *Jacques Cartier*, which carries weather experts and disseminates and broadcasts weather forecasts daily in both English and French, aided by reports from shore stations and from ships within call.

ATOMIC RADII IN CRYSTALS.—In a short paper in the Proceedings of the U.S. National Academy of Sciences for February, Dr. R. W. G. Wyckoff discusses, with the aid of numerical data, the hypothesis that the atoms of each element are of a definite size, and that crystals are built up by their packing together. The calculation of the "sphere of influence" of atoms can now be made from four independent starting-points: from metals, from the diamond and divalent metal carbonates of the calcite group, from pyrites (FeS_2), and with the aid of cæsium dichloro-iodide ($CsCl_2I$). The metals do not fit well into the scheme, calcite and related minerals present difficulties because of the two different assignments of position which have been made to the oxygen atoms, while the results from pyrites and cæsium dichloro-iodide are in substantial agreement and are chosen as offering the basis for the fairest test of the hypothesis. It is claimed that numerous results (given in the paper) not in accord with the hypothesis show conclusively that the latter is not in harmony with experiment—a result which might be anticipated on theoretical grounds, although approximate agreement is obtained in isomorphous crystals composed of only two kinds of atoms, where the interatomic distances have additive properties. In cases of compounds where the atomic environments are different, the interatomic distances may change by several tenths of an Ångstrom unit.

GASOLINE IN THE UNITED STATES.—The natural-gas gasoline industry in the United States continues to expand, and the total production of nearly 450,000,000 gallons of gasoline in 1921 exceeded that of 1920 by some 145,000,000 gallons, according to statistics recently published in an advance chapter of the Mineral Resources of the United States for 1921. The value of the gasoline produced, however, dropped to 10,000,000 dollars less than in the previous year, owing to the break in the petroleum market and the general lowering of prices. The processes involved in the production of natural-gas gasoline are constantly undergoing changes, and there is obviously still plenty of room for improvement of the plants employed. The compression process of extraction is fast giving way to the absorption process, not because the latter is technically more efficient, but because the product obtained by the absorption process is more uniform, stable, and commands a higher market price. The combination of both compression and absorption processes, however, is finding increasing favour with operators, and may quite conceivably become the standard plant of the future. Production of gasoline on a large scale is faced with certain problems which are not always easy to contend with; for example, summer temperatures frequently cause difficulty in cooling the water sufficiently for condensation, while cold weather, on the other hand, aids condensation to such an extent that pipe-line freezing occurs, interrupting the transport of the gasoline. Another problem seriously affecting the industry is that connected with waste of gas which must inevitably occur when a new well is brought in; obviously, in operating a new lease, it is not policy to install an expensive plant until the probable output of gas from several wells has been gauged; drilling these new wells takes time, and thus in developing a property much gas is initially lost which it would undoubtedly pay to treat for gasoline.

The Royal Society Conversazione.

THE first of the two annual conversaziones of the Royal Society was held at Burlington House on May 16, when Sir Charles Sherrington and the officers of the Society received the fellows and guests. In the space available it is impossible to deal adequately with all the exhibits, so we propose to group them according to subject and to give a brief account of some of the items in each group.

The National Institute of Industrial Psychology exhibited some results of the researches it has undertaken, among which were curves obtained by Dr. G. H. Miles and Mr. Eric Farmer showing the effects of encouraging rhythmical movements and of reducing needless decisions. Output increased by more than 35 per cent., despite which the workers spontaneously testified to their lessened fatigue. Mr. Eric Farmer also demonstrated the reduction of after-images produced by using a frosted glass on the miner's standard electric lamp.

The effect of temperature on the biological action of light was illustrated in a demonstration arranged by the National Society for Medical Research (Dr. Leonard Hill and Dr. A. Eidinow). Hay infusoria were exposed in shallow quartz cells to the mercury vapour lamp. The quartz cell in each case is attached to a glass cell through which water is circulated at a given temperature. The lethal power of ultra-violet rays is manifested by granulation and loss of mobility, and at 20 C. these signs appear in about one-third of the time required at 10 C. Mr. H. J. Buchanan-Wollaston had an interesting exhibit showing the value of markings on herring-scales as a means for estimating age and growth rate of the fish. Scales from the same fish may have widely differing numbers of rings; those on the outer part of the large scales should be read in groups, and the age checked by means of dorsal scales and "key-scales." The ages deduced are much less than those obtained by Danish workers.

Some developments in microscopy were illustrated by the exhibits of Mr. Conrad Beck and the National Institute for Medical Research (Mr. J. E. Barnard, Mr. John Smiles, and Mr. F. Welch). Mr. Beck showed a new illuminator for opaque objects, consisting of an aplanatic ring of glass silvered on the back surface, which enables a short focus reflector of great light intensity to be used with powers as high as 4 mm. (1/6).

The Director, Royal Botanic Gardens, Kew, showed specimens of efwatakala grass (*Melinis minutiflora* P. Beauv.), a valuable pasture grass in the tropics, reported to be repugnant to the tsetse fly. This property appears to be due either to the aroma of the oil exuded by the hairs on the leaves or to its stickiness. In another exhibit, species of Psychotria, Pavetta, and Kraussia (Rubiaceæ) with nodular swellings in their leaves, due to the presence of colonies of bacteria, were shown. The bacterium can assimilate free nitrogen from the air. The Physical Department, Rothamsted Experimental Station, Harpenden (Dr. B. A. Keen, with Mr. E. M. Crowther and Mr. W. B. Haines), had exhibits dealing with flocculation and deflocculation in soils. An automatic electrical balance, devised by Prof. Oden and Dr. Keen, gives a continuous time record of the accumulating weight of deposit from a soil suspension. Analysis of the time-weight curve thus obtained gives an indication of the type of soil.

Messrs. J. J. Griffin and Sons, Ltd., showed a "Boys" integrating and recording gas calorimeter which has already been described in NATURE (August 19, 1922, vol. 110, p. 251). Dr. Hele-Shaw exhibited his stream-line filter, which causes the fluid which has to be filtered to flow with stream-line motion. This is done by forcing the fluid down holes drilled through parallel sheets of paper impervious to the fluid itself; the fluid escapes by passing between the sheets of paper. Dirty water and oil, and water containing a dye, were all freed of foreign material. Among the exhibits of the International Western Electric Company was a low voltage kathode ray oscillograph. The instrument consists of a glass tube in which a kathode ray is generated between a hot filament kathode and a small tubular anode. The ray is rendered visible by striking a fluorescent screen at the end of the tube. It is deflected on passing between two pairs of plates to which two alternating potentials are applied. The fluorescent spot then traces out a curve which is a graph of the relation between the two potentials. Among the exhibits of the Research Department, Woolwich, was an apparatus for the detection of feeble X-ray beams by smoke clouds. A smoke cloud, having a flat top, is produced in a small chamber, below an electrode maintained at a potential of about 400 volts. Even a feeble X-ray beam striking the cloud produces ions, some of which attach themselves to the smoke particles, and the latter can be seen rising from the top of the cloud. A chronograph for use with a photographic recorder was also shown. Time intervals of 1/1000th second are recorded on a moving cinematograph record by interrupting the spot-light from an Einthoven galvanometer by means of a wheel with 20 radial vanes, which is made to revolve at 50 revolutions per second. The accuracy of the recorder for long or short time intervals is at least 1/10,000th second.

Mr. S. G. Brown exhibited a frenophone, a form of loud-speaking telephone, in which the sound is amplified by friction. The telephonic current controls the pressure of a small cork pad upon a revolving glass disc, and the variations in the resulting frictional drag are applied to the telephone diaphragm of the instrument. Very clear articulation is produced. In an exhibit by the Cambridge and Paul Instrument Co., Ltd., a phonic motor driven by a tuning-fork controls a contact on a circular rheostat, which is rotated by a direct-current motor. If the latter gains or loses speed relatively to the phonic motor, the rheostat automatically synchronises the motor with the tuning-fork. The mechanism was designed by Dr. W. Rosenhain.

Curious as well as interesting were the exhibits of Mr. Harrison Glew, who showed a bar magnet of cobalt-steel floating above the opposed poles of a fixed magnet (NATURE, May 12, p. 609), and of Mr. E. Hatschek, who had a number of permanent "hanging drop" and vortex forms produced by running gelatin sol into suitable coagulating solutions, while the device of Mr. D. Northall-Laurie, showing photomicrographs of crystals in colour mounted to show changing tints, was very striking. Colour photographs (Paget process) are taken of the subject, and the slides are constructed to allow the viewing screen to be moved across the transparency. The tint of the slide then changes from green through various intermediate colours to red, just as the tint of crystals examined under a microscope by polarised light can be made to change. There were other specimens and pieces of interesting apparatus, such as that shown by Messrs. Adam Hilger, Ltd., for optical research, but a fuller account cannot be attempted.

During the evening, Sir Richard Paget lectured on the reproduction of vowel sounds, and Mr. Walter Heape on the Heape and Gryll rapid cinema machine.

Conference of Universities.

IN the programme of the annual conference of the universities of the United Kingdom, which was held on May 12 at King's College, London, the first place was given to the subject of the financial outlook of the universities. The income and expenditure for 1921–22 of the universities and university colleges of Great Britain in receipt of annual Treasury grants are displayed in Tables 7 and 8 of the returns recently published by the University Grants Committee. The aggregate income of these institutions (Oxford and Cambridge are excluded from the returns, their grants having been "special emergency" grants) is shown as 3,578,768*l*., derived from: Parliamentary grants (35·3 per cent.), Fees for tuition and examination (35·7 per cent.), Local Authorities' grants (11·7 per cent.), Endowments (10·3 per cent.), Donations and Subscriptions (2·7 per cent.), and other sources (4·3 per cent.). Of expenditure 49·3 per cent. was on Salaries of Teaching Staff, 13·4 per cent. on other Departmental Maintenance, 13·1 per cent. on Maintenance of Premises, and 10·2 per cent. on Administration.

The outstanding feature of the situation is the cramping of university activities owing to want of funds. "The grave condition of commerce and industry," says the Committee, "has temporarily called a halt to the forward movement which derived its impulse from the experience of the War: such a halt was natural—perhaps inevitable—but it cannot be prolonged without arresting developments which can only be neglected at grave risk to national efficiency." The Committee finds in the universities' expenditure on their libraries an illustration of the parsimony which they are compelled to practise. In a report dated February 3, 1921, the Committee directed special attention to the vital necessity of proper provision for library maintenance and declared that the character and efficiency of a university may be gauged by its treatment of this, its central organ, and it now characterises the expenditure on libraries and museums in 1921–22 as "dangerously small." The whole expenditure under this head was about as much as is spent on the upkeep of their libraries by the two universities of Chicago and California. The Committee is satisfied that at practically all the universities the greatest care has been taken to limit expenditure to essentials, and to get full value out of every pound spent. It follows that if the developments so urgently necessary for national efficiency are to take place, the universities' incomes must be augmented.

The discussion at the conference followed generally the lines of Dr. Adami's paper read at the Universities' Congress of 1921, and was directed especially to the question how far it is possible and desirable to obtain increases of annual grants from Local Authorities. Sir Theodore Morison suggested that provincial universities may be regarded as beneficial alike to (1) their students, (2) the cities they are located in and the surrounding districts, and (3) the nation; and that where more than two-thirds of the university's income is obtained from the students and the nation, it is not unreasonable to look to local sources for an increase of their contribution. He adduced statistics showing that if cities which at present grant to their universities less than the produce of a penny rate, and counties and neighbouring boroughs which make grants equal to less than a halfpenny rate, were to increase their grants to these standards respectively, the English provincial universities would benefit to the extent of 55,000*l*., or 4 per cent. of their total incomes; there are, moreover, a number of counties and boroughs within the spheres of influence of universities which do not at present make grants to them. Nor should it be difficult to convince local bodies of the great value to their constituents of a flourishing university in their midst. The services the universities can render to local communities may not be measurable in terms of money, but are not the less substantial, among them being assistance in the scientific development of local industries and the fostering of a spirit of regional independence. General appreciation on the part of local authorities of the value of such services should go far to minimise the dangers, to which attention was directed by several speakers at the conference, of dependence on grants out of rates.

With the exception of a remark by the president of the Board of Education to the effect that he believed the race of "pious donors" is not yet extinct, no suggestion was made as to the possibility of increasing endowments. The income from endowments not appropriated to specific purposes is shown in the Grants Committee's tables to amount at present to 155,230*l*., or 4 per cent. of the total income; the income from appropriated endowments is 215,350*l*. Several speakers acknowledged the inestimable value of the services to the universities of Sir William McCormick's Committee in helping them to meet the crisis in their finances produced by the War. The president of the Board of Education, while assuring the universities that there is at present no disposition in Parliament to challenge their autonomy, observed that they would always need to be on their guard against claims that with the extension of State aid should go extension of State control.

In opening the discussion on "Music as a University Subject," Sir Henry Hadow made a vigorous plea for full recognition by the universities of the study of musical works as being on a par with, if not a part of, literature. This recognition would involve its acceptance as an optional subject for the B.A. degree. The discussion brought to light the fact that alike in London, in Wales, and in Scotland, the recognition of music as an optional subject for matriculation is being considered, and that the northern English universities' joint matriculation board has adopted, and the Oxford and Cambridge schools examination board is considering, an adequate music syllabus for their school certificate examination.

The discussion on "The Universities and Training for Administrative and Municipal Life," opened by Sir William Beveridge, who was ably followed by Sir Josiah Stamp, showed that the liveliest interest is being taken in this subject both within and without the universities, and that this has been greatly stimulated by the establishment last year of the Institute of Public Administration. Most of the speakers were in favour of the universities providing in this connexion, not preliminary professional training, but courses suitable for persons who have already entered on their official careers. The courses would be framed in consultation with representatives of central and local government authorities with the view of junior officials being released from their ordinary duties for attendance on them.

Mr. Arthur Greenwood, M.P., spoke on "Labour and the Universities," and a paper by the Master of Balliol on extra-mural education was read.

The discussions were marked throughout by an animation which proved that the subjects were well chosen. A report of the proceedings will, we are informed, be published by the Universities' Bureau.

The Department of Geology, University of Liverpool.

NEW GIFT FROM SIR WILLIAM HERDMAN.

ON Tuesday, May 15, the Council of the University of Liverpool accepted a gift of 20,000*l*. from Sir William A. Herdman for the provision of a new building for the Department of Geology. Sir William Herdman desired his gift to be associated with the memory of the late Lady Herdman, and that the new laboratories should bear her name. It will be recollected that, after urging for many years the desirability of the foundation of a chair of geology in the University, Sir William Herdman, in company with Lady Herdman, eventually offered the University the sum of 10,000*l*. for the purpose of endowing the George Herdman chair in memory of their only son, who was killed in action in 1916.

Largely through the foresight of Sir William Herdman and Sir Alfred Dale, the late Vice-Chancellor of the University, accommodation had been reserved in an extension of the Zoology Department. The Geological Department thus consisted of two floors and a library, but the new professor had the great advantage of dividing up the shell of the building into suitable laboratories and of equipping them for special needs. Sir William Herdman had been securing for many years valuable collections and books in preparation for the future department. The equipment of the laboratories was assisted very materially by a gift of 2000*l*. from Mrs. and Miss Holt, relatives of Lady Herdman, long well known for their great and numerous benefactions to the University. Many other donations towards equipment and the cost of purchasing collections, etc., were made by Sir William and Lady Herdman in the succeeding years, and several students in the Department had reason to be grateful for their kind and practical help.

The School of Geology, founded in 1917, has grown rapidly—not unexpected, when it is remembered that Liverpool has long been known for such distinguished amateur geologists as G. H. Morton, C. Mellard Reade, H. C. Beasley, and J. Lomas, and its active Geological Society with a sixty years' record of published work. The accommodation of the Department has for the past three years been insufficient for its needs, and Sir William and Lady Herdman frequently expressed their desire to see the school housed more fitly. Lady Herdman's sudden and lamented death last autumn prevented the new gift being a joint one, but it was a happy thought of Sir William Herdman to associate the names of wife and son with the laboratories and chair respectively.

Apart from this valuable assistance towards the furtherance of geological work, it may be recalled that in 1919 Sir William and Lady Herdman also endowed the chair of oceanography in the University.

University and Educational Intelligence.

ABERDEEN.—Dr. H. R. Kruyt, professor of physical chemistry in the University of Utrecht, delivered a University lecture on May 14, his subject being "The Electric Charge of the Colloids."

The Students' Gala Week in aid of the Aberdeen Hospitals has realised a nett sum of 4753*l*.

Prof. J. Arthur Thomson has been appointed a member of the committee of inquiry on trawling.

ST. ANDREWS.—Among the names of those on whom the Senatus Academicus has resolved to confer the honorary degree of LL.D. at the graduation ceremonial on July 6 are the following:—Sir William Henry Hadow, vice-chancellor of the University of Sheffield; Mr. Herbert William Richmond, University lecturer in mathematics in the University of Cambridge, and retiring president of the London Mathematical Society; and Sir Robert Robertson, chief Government chemist, London.

BIRMINGHAM.—The Huxley Lecture is to be delivered on Thursday, June 7, 5.30 P.M., at Mason College, by Sir Arthur Keith, who has chosen as his subject "The Origin of the British People."

Dr. H. H. Sampson has been appointed honorary assistant curator of the surgical section of the Pathological Museum, and Mr. J. S. M. Connell, honorary assistant curator of the gynæcological section.

Prof. John Robertson is to represent the University at the meeting of the National Association for the Prevention of Tuberculosis, to be held in Birmingham in July next.

The Ingleby Lectures will be delivered at 4 o'clock on May 30 and June 6 by Dr. H. Black, who will take as his subject "The Investigation of the Alimentary Tract by X-rays." The lectures are open to all medical men.

CAMBRIDGE.—Dr. W. L. H. Duckworth, Jesus College, has been elected as representative of the University on the General Medical Council.

Dr. E. Lloyd Jones, Downing College, has been re-elected demonstrator of medicine. An honorary degree of Master of Arts is to be conferred on Dr. J. T. MacCurdy, Corpus Christi College, University lecturer in psychopathology.

DURHAM.—An anonymous donor has presented the capital sum of 12,000*l*. to Armstrong College, Newcastle-upon-Tyne, the interest of which is to be devoted to the establishment of research fellowships and possibly prizes of similar character to the Adams prize at Cambridge, or in such other manner as the Council of the College may decide is best calculated to promote original work in pure and applied science and the humanities.

The Council of the College has decided to proceed immediately with the erection of a permanent library at an estimated cost of some 40,000*l*. It has long been felt that there is great need of a scholars' library on the north-east coast, and it is hoped that when the new library is built it will form a worthy centre for all students of the district, whether members of the University or not. It is understood that the Unemployment Grants Committee are favourably disposed to consider such a scheme as a work of public utility deserving assistance from public funds.

EDINBURGH.—On Wednesday, May 16, Prof. H. R. Kruyt, of the University of Utrecht, delivered a lecture on "The Electric Charge of Colloids"; and on Friday, May 18, Prof. W. de Sitter, of the University of Leyden, lectured on "Problems of Fundamental Astronomy."

LONDON.—Prof. Leonard Bairstow has been appointed as from September 1 next to the Zaharoff chair of aviation tenable at the Imperial College of Science and Technology. He has been head of the Aeronautical Department of the National Physical Laboratory, and since 1920 has been professor of aerodynamics at the Imperial College.

Dr. C. L. Boulenger has been appointed as from September 1 next to the University chair of zoology tenable at Bedford College. Since 1922 he has been lecturer in, and temporary head of, the department of zoology at the college. He is the author of a number of papers on Cœlenterata, helminthology, and other subjects.

Miss B. E. M. Hosgood has been appointed as from September 1 next to the University readership in geography tenable at Bedford College. In 1918 she was appointed assistant lecturer in geography at the College, and has been since 1920 head of that department.

Dr. John Marshall has been appointed as from September 1 next to the University readership in mathematics tenable at Bedford College. He has been junior lecturer in mathematics at University College, Dundee, and senior lecturer in mathematics at University College, Nottingham. Since 1920 he has been senior lecturer in mathematics at University College, Swansea.

OXFORD.—On May 15 a decree was passed by Convocation authorising the presentation of an address to the Universities of Paris and Strasbourg on the occasion of the celebration of the centenary of the birth of Louis Pasteur.

It has been decided to offer an annual scholarship in chemistry under the will of the late Charles Day Dowling Gibbs.

A prize in natural science has been established by Mrs. Emily Poulton, in memory of her daughter, Hilda Ainley Walker, open to women members of the Society of Oxford Home-Students.

THE Ellen Richards Research Prize of 1000 dollars, for 1924, is being offered for theses by women, based on independent laboratory research. If the prize should not be awarded, a grant may be made under certain conditions. Information respecting the prize, and application forms, are obtainable from Dr. Lilian Welsh, Goucher College, Baltimore, Maryland, U.S.A., or from Mrs. Samuel F. Clarke, Williamstown, Mass., U.S.A.

THE Dr. Edith Pechey Phipson post-graduate scholarship, value 100*l.* a year for not more than three years, will be awarded in June by the council of the London (Royal Free Hospital) School of Medicine for Women. The scholarship is open to all medical women, preferably coming from India, or going to work in India, and is for assistance in post-graduate study. The latest date for the receipt of applications (which should be sent to the Warden and Secretary of the School, 8 Hunter Street, W.C.1) is May 31.

THE Board of Education is organising short summer courses of instruction for teachers in technical and evening schools (Form 105e. U.). Engineering science and electrical engineering are dealt with at Oxford and Birmingham. Both courses commence at Birmingham on July 23 and are concluded (July 28 to August 8) at Oriel College, Oxford. The courses include practical work on heat engines, hydraulics, mechanics, materials, electrical testing, wireless, thermo-electricity and magnetic testing. Building science is divided into two courses, (*a*) building mechanics and structures and (*b*) general science and laboratory work, both at Westminster Training College, Horseferry Road, London, S.W.1. Applications to attend these courses, to be obtained and returned through the local Education Authority if the teacher is working under such an authority, must be received by the Board of Education not later than June 1.

THE Manchester Municipal College of Technology is this year celebrating its "coming of age." It originated in a Mechanics' Institution founded in 1824 with the object, common to many similar foundations of the second quarter of the nineteenth century, of "enabling mechanics and artisans to become acquainted with such branches of science as are of practical application in the exercise of their trades." Conceived without much regard to the principles of industrial psychology, the methods employed commonly failed to attract people of the class for whom they were intended, and thirty years after its foundation a vice-president of the Manchester institution remarked, "Nature was as bountiful to the working-class in talent and energy as to the higher classes," but "those for whom this institution was destined did not avail themselves of it," and "until we enforced education upon all classes, Mechanics' Institutions, successful as they might be to some classes, would not produce the great advantage they might otherwise do." The Paris exhibition of 1867 having attracted attention to a growing inferiority of English arts and crafts, a cry was again raised for technical education among workmen, and this was echoed by the directors of the Manchester institution, who in their report for 1868 approved of "recurring to a system of education, the basis of which was prescribed in the original preamble, viz. to instruct the working-classes in the principles of the arts they practise." In 1882 it was converted into a technical school, which was in 1892 taken over by the City Corporation. The College into which it has grown had in 1921–22 an income of 143,000*l.*, of which nearly 64 per cent. (more than the produce of a 4d. rate) was provided by the Corporation. Of the 6223 students 553 were taking courses of university standard. An interesting series of articles upon the work and development of the College has been contributed to the *Manchester City News* by the former principal, Mr. J. H. Reynolds.

AMONG the various links connecting abstract science and engineering is the scientific education of engineers. Thirty years ago Sir William Anderson deplored the fact that except in the noble endowments of the City and Guilds schools and the Government institutions at South Kensington in London, the movement to secure the necessary training languished for want of adequate support. Sir Richard Glazebrook, in his "James Forrest" lecture to the Institution of Civil Engineers on May 4, made reference to this, and gave a brief outline of the conditions at present. The City and Guilds College—the Engineering Department of the Imperial College—opened in 1886 with 35 students; in July 1922 there were 492 engineering students in the College, and 138 students of the Royal College of Science and the Royal School of Mines were also receiving instruction. The numbers for the Schools of the University of London and its other institutions were not quoted, but it may be said that these show corresponding increases. In the period from 1903 to 1922 London University conferred 1294 internal and 756 external engineering degrees. The growth in the provincial universities and colleges has also been very large. Among other hopeful signs is the increasing interest in the education of apprentices shown by trades unions; a report on this subject was presented at the Trades Union Congress last year. The scheme of industrial bursaries started in 1911 by the Royal Commission for the Exhibition of 1851 is for the award of bursaries to students who have done well in some branch of science and who propose to go into works. Up to December last about 19,000*l.* has been expended on 185 bursars. The scheme is an extremely useful one and could be extended with advantage. Many young men find it extremely difficult, after a successful college career, to obtain adequate works experience without causing an intolerable drain on the slender resources of their parents. It is also of interest to record that there is an increasing demand by employers for college-trained men; the associations of works and colleges were greatly strengthened during the War, and many firms now prefer men for their staffs who possess university degrees.

Societies and Academies.

LONDON.

Royal Society, May 17.—A. E. H. **Tutton**: (1) A universal interferometer. The essential feature is a travelling microscope driven by a specially constructed fine screw along a true V-and-plane guiding bed; one of the two glass reflecting surfaces is carried rigidly with it, and the amount of its motion is measured directly in monochromatic interference bands. There is an autocollimating telescope with micrometer eyepiece, a vacuum tube on the elbow tube, a constant deviation prism for the selection of the monochromatic radiation to be used, and large truly worked glass interference discs. The telescope is mounted to the right, and the driving wheel to the left, and the 30-inch long V-and-plane bed, in its rigid carrying plinth-bed, is supported on pillars at the Airy positions for no flexure, the whole being mounted on a heavy rectangular base. The large middle space on the latter is available for a large circular work-table with every possible requirement of adjustment for supporting the object or its manipulating apparatus. (2) A wave-length torsometer, and its use with the universal interferometer. This is a refinement of the Voigt instrument for determining the torsion constants of small bodies. It is essentially a miniature lathe-bed, carrying two similar but mutually reversed wheel-and-chuck fittings, the chucks for gripping the object bar ends, and the wheels, which move solidly with the chucks, for delivering the force-couple at one end and holding the object firmly at the other, the two ends being interchangeable. The power band passes round the lower half of one pulley-wheel and thence over a larger pulley-wheel on a standard. The end depending from in front of the latter terminates in a loop of the cord-band, into which the hook carried by the weight can be allowed slowly to fall, until the whole weight is acting in twisting the object bar. The torsometer is supported on the work-table of the universal interferometer. It is rigidly clamped with the two aluminium radials carried by the object bar near its two ends, in contact near their upper terminations with the blunt knife-edge ends of the two sliders. The Grayson-ruling signal is centred under the microscope when the radial under observation is just in complete contact with the slider. On delivering the weight and effecting the twist, the slide and signal move, and the movement is followed by driving the microscope by the big wheel of the interferometer until the signal mark is again centred, the number of interference bands effecting their transit being counted.—L. N. G. **Filon** and F. C. **Harris**: On the diphasic nature of glass as shown by photo-elastic observations. A block of flint glass was heated to about 400° C., when it showed some signs of softening; it was then allowed to cool under longitudinal pressure. On removing the pressure it was found to have become permanently doubly-refracting. The residual stress which should produce the observed amount of double-refraction does not balance according to the laws of statics. It is deduced that a "crypto-stress" exists, which does not manifest itself optically. This leads to the conclusion that the glass is not homogeneous, but behaves as a mixture of two components or phases.—C. E. **Inglis**: Stress distribution in a rectangular plate having two opposing edges sheared in opposite directions. Imagine a thin rectangular plate bounded by two horizontal lines AB CD and two vertical lines AD BC. The two horizontal edges, while remaining straight and unchanged in length and in distance from one another, are displaced longitudinally in opposite directions, the vertical edges being kept free from applied stress. The plate being thin, the distribution of stress consequent on this deformation is regarded as two-dimensional and the stress components are obtained through solutions of $\nabla^4 V = 0$. Along the horizontal centre line the stress starts from zero at the free edge, increases rapidly, and, for a plate in which the length is considerable compared with the depth, the stress soon assumes a constant value; but before doing so, it overshoots this value, and the curve of stress distribution in consequence develops humps near the free vertical edges. If the length–breadth ratio of the plate is 2 to 1 these humps combine to give a flat-topped curve. If the plate is square the coincidence of the humps makes the curve approximate to a parabola.—T. H. **Havelock**: Studies in wave resistance: influence of the form of the water-plane section of the ship. In these calculations the ship is represented by a vertical post of infinite depth the horizontal section of which is similar to the water-plane section of a ship. The level lines of the model are varied, while the displacement is kept constant. In this manner a comparative study is made of such problems in ship resistance as the effect of finer lines and greater beam and of the difference between straight and hollow lines.—W. M. H. **Greaves**: On a certain family of periodic solutions of differential equations, with an application to the triode oscillator. There is, under certain conditions, a discontinuous family of periodic solutions of the equations $dx/dt = \mu\xi$, $dy/dt = \lambda(x) + \mu\eta$, where $\lambda(x)$ is a function of x only, ξ and η are functions of x and y, periodic in y with period 2π, and expressible as Fourier Series in sines and cosines of multiples of y, the coefficients being functions of x, not involving t explicitly, and μ is a constant parameter. An application is made to the equation of Appleton and Van der Pol for the triode oscillator the equation of which can be reduced to a particular case of the above equations.

Geological Society, April 18.—Prof. A. C. Seward, president, and, afterwards, Dr. H. H. Thomas, vice-president, in the chair.—J. F. N. **Green**: The structure of the Bowmore-Portaskaig district of Islay. Quartzite is defined as containing a limit of 10 per cent. of felspar, more highly felspathic rocks being termed "arkose." On this definition the Islay upper quartzite is throughout true quartzite; but the so-called lower quartzite is not quartzitic, being composed of arkoses and greywacke-slates identical with the matrix of the Portaskaig conglomerate; they have been grouped together as the Portaskaig beds. Thus the dolomitic group intervenes between the Portaskaig beds and the Islay quartzite. The supposedly Torridonian Bowmore sandstone consists of arkoses and flags. The flags, which, owing to isoclinal folding, have apparently an enormous thickness, are identical in minute detail with certain siliceo-argillaceous flags that always occur in the dolomitic group next to the Islay quartzite. They are termed the Bowmore flags. Thus there is no change of facies at the supposed thrust, and its presumed line of outcrop shows that the rocks are folded up without disruption, except for some shearing on the reversed limbs of overfolds. The Loch Skerrols thrust is non-existent. The Bowmore flags are perfectly conformable to the white edge (a well-marked horizon) of the Islay quartzite; the dolomitic flags associated with them are partly or wholly cut out in places by the Portaskaig beds. The latter are probably younger than the dolomitic group. On Beannan Dubh the rocks lie in isoclinal folds with low dip, by which the Portaskaig conglomerate is brought up in anticlines. The structure of Islay is probably synclinal. Only one system of folding is required to explain the facts.

May 2.—Prof. A. C. Seward, president, in the chair.—J. Joly: The bearing of some recent advances in physical science on geology. In his lecture, Prof. Joly dealt with the subjects discussed in the article "Surface Movements of the Earth's Crust" in NATURE of May 5, p. 603.

Royal Anthropological Institute, May 1.—Mr. H. J. E. Peake in the chair.—V. Gordon Childe: The Neolithic painted pottery of south-eastern Europe. The sites in question extended from the banks of the Dnieper in the Kiev Government to the slopes of the Carpathians, and are restricted to the fertile "black earth" belt. Three groups were found: an eastern group along the Dnieper (the Tripolje culture proper) with much incised ware; a central group in Bessarabia, Moldavia, Bukowina, and Eastern Galicia, where pottery with black paint predominated, and a western group represented by Koszylowce west of the Sereth with polychrome painting. At Cucuteni in Moldavia an older phase of this culture was discovered with polychrome pottery and good spiral designs. The painted pottery comes either from large rectangular structures of wattle and daub called *ploshchadky* or from huts partly hollowed out in the earth (*zemlyanky*). No hearths have been found in the former, but the latter regularly contain an oven situated in a deeper trench filled with kitchen refuse. No authenticated metal finds were reported from Schipinitz, and at other parallel stations (except Cucuteni II.) metal was either completely absent or represented only by small implements of pure copper. Polished stone axes were also very rare, but fine flints and numerous artefacts of bone date the culture to the last phase of the stone age. The culture of the "black earth" was apparently terminated by the incursion of nomadic tribes.

May 14.—Dr. A. C. Haddon, past-president, in the chair.—Mr. J. E. P. Murray: Native administration in Papua. The principle that government of the backward races should be in the interests of these races themselves has been followed by the Australian Government in the administration of Papua. It is necessary, however, to understand the Papuan character if an intelligent native policy is to be pursued, and on this account an anthropological department was instituted. The indenture of women is not allowed in Papua except for domestic purposes under certain conditions. The indenture of women would probably result in the breaking up of village life, which would put an end to any possibility of developing the territory through native enterprise. Changes introduced into native life by the arrival of the white man can be classified as (1) moral; (2) material; for the latter the Government must find a remedy or it fails in its duty altogether. One most obvious remedy is work, not merely in the interests of the white employer, but work for the native's own interest and on his own land. The introduction of the native tax in Papua has made it possible to deal comprehensively with the question of native plantations, and plantations worked by natives in partnership with the Government. The proceeds of the tax are used only for native education and for other purposes directly for the benefit of the natives. In the future the danger to the native under Australian rule lay in "benevolent capitalism."

Linnean Society, May 3.—Dr. A. Smith Woodward, president, in the chair.—W. T. Gordon: Fossil coniferous genus Pitys. The specimens were obtained from beds of siliceous volcanic ash, at Gullane, 17 miles east of Edinburgh, and comprised a new species, showing cortex and leaves; hitherto nothing was known of the genus, except pith and wood.—R. Gurney: The Crustacean plankton of the English Lake district.—S. L. Ghose: A systematic and ecological account of a collection of Blue-green Algæ from Lahore.—J. Groves: Notes on Indian Charophyta. In 1882 representatives of the genera Chara and Nitella only were known from India. Now a Nitellopsis, a Lychnothamnus, and three species of Tolypella have been recorded. Within the past three years, in a comparatively small area, Mr. G. O. Allen added three well-marked species to the Indian flora besides rediscovering *C. Wallichii*, of which only the male plant collected in 1809 by Dr. Wallich was previously known, and establishing the occurrence of *Nitellopsis obtusa* (in Kashmir), the only previous Asiatic record of which was dependent on a poor specimen from Burmah.—J. G. H. Frew: On the morphology of the head-capsule and mouth-parts of *Chlorops tæniopus* Meig. (Diptera).—A. M. Alston: On the genital system of the wood-boring beetle, *Lyctus brunneus* Steph. Both of the ovipositor and the rectum are of great length.

Aristotelian Society, May 7.—Prof. A. N. Whitehead, president, in the chair.—L. J. Russell: Some problems in the philosophy of Leibniz. The metaphysical concept of the monad was reached in the later part of Leibniz's philosophical development and the sources of the doctrine are only to be discovered by studying his writings, many of which are undated manuscripts, chronologically. In the "Discourse on Metaphysics" (1686) we find he has arrived at the conception of created substance. It was this conception which provided for him a rational justification of his view of the relation of God to the universe and of his conception of the universe as a harmony. It was into this framework that the monadology was fitted. Leibniz seems never to have doubted the validity of the conceptions of God as the architect of the world machine, and as the ruler of the republic of spirits. The first saved him from the pantheism of Spinoza, which would have made the second irrational. The reconciliation of the two conceptions presented the chief problem of his philosophy.

Zoological Society, May 8.—Dr. A. Smith Woodward, vice-president, in the chair.—H. Burrell: Note on a hibernating female specimen of the marsupial *Acrobates pygmæus*.—F. M. Duncan: The microscopic structure of mammalian hairs, with especial reference to the hairs of the primates.

Optical Society, May 10.—Mr. T. Smith, vice-president, in the chair.—J. W. French: Stereoscopy re-stated. Stereoscopic vision is possible only within certain limits. For certain pairs of objects, whether on the same or different horizons, there are generally two extreme critical points beyond which stereoscopic vision breaks down. For certain pairs of objects on the same horizon there are two inner critical points. Objects of dissimilar form but approximately the same average angular dimensions can frequently be combined stereoscopically; thus a circle can be combined with a triangle if their average angular dimensions are about equal. When the angular dimensions are very different, combination is generally impossible; thus, for example, a thin line cannot be combined with a thick line or triangle. When the pairs of objects are dissimilar in size, there is only one pair of outer and inner critical points if the objects are on the same horizon and one outer critical point if they are on different horizons. For pairs of objects any of which can be combined together, there are two pairs of such critical points.

Royal Meteorological Society, May 16.—Dr. C. Chree, president, in the chair.—M. de Carle S. Salter and J. Glasspoole: The fluctuations of annual rainfall in the British Isles considered cartographically. Maps expressing annual rainfall 1868–1921 as a percentage of the average, fall roughly into three types, indicating respectively (i.) excess of orographical rain, (ii.) deficiency of orographical rain, (iii.) excess of cyclonic rain. The mean range of variation per annum is 35 per cent., with local extremes varying from +80 per cent. to −59 per cent. In the earlier years the maxima were generally in the east: in the middle of the period in the west: and in the later years in the south. The general rainfall varied from 136 per cent. in 1872 to 77 per cent. in 1887, the deviation exceeding 20 per cent. in only 5 years, and averaging 8 per cent. From 1868 to 1882 maxima occurred at intervals of 5 years; from 1889 to 1909 of 3 years; and from 1910 to 1921 of 2 years. There is also evidence of a long-period fluctuation with two maxima about 40 years apart. Annual pressure maps for the same series of years appear to show three main types of variation due to (i.) shifting of the S.W. wind drift to N. or S.; (ii.) changes in the gradient; (iii.) local deflections of the isobars. Type (i.) appears to determine the amount of general rainfall; type (ii.) determines the distribution of rainfall; type (iii.) affects both variables, and includes all extremely dry or wet years.—A. W. Clayden: An improved actinograph; note on the influence of a glass shade. Two similar bimetallic coils, like those used for thermographs but with 7½ turns each, are mounted about a common axis and attached to a recording pen, in such a manner that the movements of the pen register only the difference of temperature between the two coils. The axis is fixed in a position parallel to the polar axis with the coils at its ends. The instrument stands in a case so that the coil at the lower end is shaded from the sun, while the coil at the upper end is exposed under a hemispherical glass shade to full sunlight and is blackened. The records for five consecutive years from February 1914 show a rapid rise of radiation during January to April, a slight drop about the middle of May followed by a rise to June and a fall during the latter half of the year which is notably more gradual than the vernal rise. —E. E. Benest: Notes on the "Sumatras" of the Malacca Straits. These squalls usually blow from the south-west, and are more frequent between April and October. A greater number is experienced between Malacca and Pulo Penang than between Malacca and Singapore. "Sumatras" always occur at night, and are generally accompanied by thunder, lightning, and torrential rain; they seldom last more than two hours. The strength of the wind is estimated as between 40 and 55 miles per hour. A characteristic cloud formation is a heavy arch or bank of cumulo-nimbus, which rises to an estimated height of about 7000 ft. and rapidly spreads over the whole heavens.

PARIS.

Academy of Sciences, April 30.—M. Albin Haller in the chair.—A. Haller and L. Palfray: The mixed and symmetrical 1-ethanoic-1-camphomethanoic esters and their saponification products. These compounds, containing both the $(CH_2.CO_2H)$ and (CO_2H) groups, attached to the same atom of the camphor molecule, form esters which are singularly difficult to hydrolyse. —A. Calmette, A. Boquet, and L. Nègre: Rôle of the *terrain* in the evolution of experimental tuberculosis in the rabbit and guinea-pig. The interval of time between the injection of tubercle culture into a rabbit and the death of the animal through tuberculosis has been proved to be inversely proportional to the number of bacilli inoculated, the bacilli arising from the same culture. With guinea-pigs and rabbits the number of bacilli injected appears to be the main factor in determining the time of evolution of the disease, and there are no indications of a factor involving variable sensibility of the individual animals.—Georges Bouligand: The singularities of harmonic functions.—A. Sainte-Laguë: Networks.—J. Haag: The gravitational field of n bodies. A correction of an earlier note on the same subject.—Louis Roy: Gauss's theorem of least constraint. This theorem of Gauss is stated to be incorrect.—M. Cisotti: Remarks on the note "Superficial circulation" by M. P. Noaillon.—F. Henroteau: Variations of the spectrum of the star θ_2 Orionis. In addition to the absorption lines due to hydrogen and other elements, a photograph of the spectrum taken at Ottawa in 1919 and January 1920 showed fine, intense emission lines. These lines were not found by O. Struve (Yerkes Observatory) in 1922, but were present on a spectrogram taken March 2, 1923. Hence this star, class B and not variable, shows bright lines only at intervals, a new phenomenon in astronomy.—Max Morand: Certain electromagnetic consequences of the principle of relativity.—L. Dunoyer: Induction spectra and spark spectra. Reply to a criticism by Léon and Eugène Block.—S. K. Mitra: The demagnetisation of iron by electromagnetic oscillations. A study of the effects of variation of the frequency of the alternating current on the residual magnetisation. The demagnetisation increases as the frequency of the oscillations is lowered.—Félix Michaud: Deformations of jellies by the action of an electric current. When a jelly is placed between two metallic electrodes, and an electric current is passed, it contracts towards the anode, and swells out near the cathode. The nature of the metal used for the electrodes is without influence. The action depends on the colloid; gelose gives a more intense effect than gelatin.—Pierre Brémond: The persistence of the colour of the ions in ceramic colours or colouring materials obtained at a high temperature. Attention is directed to the fact that some of the colours shown by ceramic products due to metallic constituents, and produced at high temperatures, correspond with those found in the salts of the same metals, or in hydrates which are stable only at low temperatures. —Mme. and M. A. Lassieur: The estimation of antimony by means of phenylthiohydantoic acid.—Marcel Pichard: Method of analysis of cocoa butter and its mixtures with vegetable fats. The method is based on the form of the cooling curve of the melted fat, when allowed to solidify slowly.—L. J. Simon and Léon Piaux: The conversion of alanine into pyruvic acid by the direct action of oxygen. Alanine can be oxidised directly to pyruvic acid by shaking with oxygen in the presence of alkali and metallic copper, but the proportion of copper present must be carefully regulated (1 molecule alanine to ¼ atom copper) and the reaction stopped immediately the absorption of oxygen ceases.—M. Aloy and M. Valdiguié: The oxidations and reductions produced by uranium salts under the influence of light. The antioxygen effect of phenols. Uranium acetate can act like an oxidising-reducing ferment. A solution of this salt, just acid with acetic acid, when mixed with glucose and methylene blue, placed in an evacuated bulb, and exposed to sunlight, oxidises the glucose and reduces the methylene blue simultaneously.—J. **Orcel**: The prochlorites of corundum rocks. These minerals, ten analyses of which are given, are divided into two sub-groups, ripidolites defined by the ratio MgO/FeO $\leq$ 3 and grochauite, with a ratio MgO/FeO = 10.—Pierre **Viennot**: The Labourd stratum, French Basque region.—Léon **Moret**: The facies of the Senonian sponges of the Beausset basin and their conditions of deposit.—C. **Kilian**: The Immidir, branch of the "Enceinte Tassilienne," Central Sahara.—René **Jeannel**: Sketch of the stocking of Europe by the species of the genus Choleva.—R. **Anthony** and F. **Villemin**: The lobation of the fœtal kidney in the primates.—Radu **Vladesco**: Diffraction of light by the eyelashes. The diffraction bands seen under certain conditions are due to the scales forming the outer envelope of the hair.—J. **Lopez-Lomba** and Mme. **Randoin**: Contribution to the study of B avitaminosis in the pigeon.—L. M. **Bétances**: Cytohemato-genesis in the Metazoa.—A. **Weber**: The inhibiting action of the internal medium of batrachians on the fecundation and the parthenogenetic activation of their eggs. In *Rana fusca* the internal medium, lymph or blood, behaves towards the activated egg as a toxic substance, to which the egg becomes permeable after puncture, while previously it was immunised against this toxic property.—Maurice **Aubertot**: The dissemination and transport of nematodes of the genus Rhabditis by Diptera.—R. **Courrier**: Remarks on the fecundation membrane of the egg of the sea-urchin (*Paracentrotus lividus*).—Edouard **Chatton** and Mme. M. **Chatton**: The influence of bacterial factors upon nutrition: the multiplication and sexuality of the infusoria.—Robert Ph. **Dollfus**: The cestode of the fine pearls of the Meleagrina of Nossi-Bé.

Official Publications Received.

Journal and Proceedings of the Royal Society of Western Australia. Vol. 8, 1921–1922. Pp. x+52. (Perth.) 5s.

Health for School Children: Report of Advisory Committee on Health Education of the National Child Health Council, Washington, D.C. (School Health Studies, No. 1: Department of the Interior, Bureau of Education.) Pp. 75. (Washington: Government Printing Office.) 10 cents.

Department of the Interior: Bureau of Education. Bulletin, 1922, No. 36: Report of a Survey of the University of Arizona. Pp. viii+89. Bulletin, 1922, No. 50: Educational Directory, 1922–1923. Pp. iii+179. 15 cents. (Washington: Government Printing Office.)

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Ltd., Turner's Hill, Cheshunt, Herts. Eighth Annual Report, 1922. Pp. 66. (Cheshunt.)

U.S. Department of Agriculture: Weather Bureau. Monthly Weather Review. Supplement No. 19: Thermal Belts and Fruit Growing in North Carolina. By Henry J. Cox. Appendix: Thermal Belts from the Horticultural Viewpoint. By W. N. Hutt. Pp. v+106. (Washington: Government Printing Office.) 50 cents.

Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1922, presented to the Annual Meeting, February 12th, 1923. Pp. 63. (York.)

Diary of Societies.

SATURDAY, MAY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—J. B. McEwen: Musical Education.

MONDAY, MAY 28.

FARADAY SOCIETY (at Institution of Electrical Engineers), at 3.—General Discussion on the Physical Chemistry of the Photographic Process.—Prof. W. D. Bancroft: Introductory Address—The Theory of Photography.—Section I. The Physical Chemistry of the Vehicle and of the Emulsion.—Dr. T. Slater Price: Introductory Address.—Prof. R. Luther: Effect of Treatment of Gelatin on the Sensitivity of the Emulsion.—E. P. Sheppard, F. A. Elliott, and S. S. Sweet: Notes on the Photographic Chemistry of Gelatin.—E. P. Wightman, A. P. H. Trivelli, and S. E. Sheppard: Structure of the Photographic Emulsion.—Dr. C. Winther: The Solubility of Silver Bromide in Ammonium Bromide and Gelatin.—At 5.—Section II. Reactions of the Plate during Exposure (including Latent Image).—Dr. F. C. Toy: Introductory Address—The Mechanism of the Latent Image Formation.—S. E. Sheppard, A. P. H. Trivelli, and E. P. Wightman: Exposure Theories.—Prof. R. Luther: The Relation between the Size of Silver Bromide Grains and Sensitivity.—W. C. Clark: Sensitivity of Silver Halide Grains in a Photographic Emulsion.—Dr. J. Errera: The Influence of the Dispersion of Asphalte Solutions on their Light Sensitiveness.—Section III. Development and Characteristics of the Developed Plate (including Optical Properties, Sensitometry).—O. Bloch: Introductory Address—Plate Sensitometry.—Prof. R. Luther: The Characteristic Curve.—Prof. R. Luther: Proportional Reducting Methods.—Prof. E. Goldberg: The Use of the Neutral Grey Wedge in Sensitometry.—T. Thorne-Baker: The Effect of Radiations of very small Wave-lengths on Optical Opacity and Gamma.—S. E. Sheppard and F. A. Elliott: The Theory of Development.—L. A. Jones: Recent Progress in the Sensitometry of Photographic Materials.—L. A. Jones: Some New Instruments for use in Photographic Sensitometry.—F. E. Ross: Optical Properties of the Photographic Emulsion.—At 8.—Section IV. Adsorption Reaction in Photographic Films.—Dr. Luppo-Cramer: Introductory Address.—Dr. Luppo-Cramer: Nucleus Isolation and Desensitisation.—A. L. Lumiere and A. Seyewetz: The Chemistry of the Red Toning of Sulphide-toned Prints.—Prof. R. Luther: Adsorption of Cupric Ion by Silver Bromide: Estimation of Traces of Copper by a New Catalytic Method.—Prof. R. Luther: Copper as Catalyst in Photographic Processes: Catalytic Effects in the Carbon Process.—E. R. Bullock: Theory of Photographic Due Mordanting.—Dr. J. Plotnikov: Future Problems in Photography.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Walford Davies: Speech Rhythm in Vocal Music (2).

ROYAL GEOGRAPHICAL SOCIETY (Anniversary Meeting) (at Æolian Hall), at 5.30.—Presidential Address.—Presentation of Medals and other awards, etc.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—G. Scott: Tradition and Originality in Italian Renaissance Architecture.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—C. D. Burns: The Contact of Minds.

ROYAL SOCIETY OF MEDICINE (Odontology Section) (Annual General Meeting), at 8.—Dr. S. Wallace: Observations on the Progress of Preventive Dentistry.

TUESDAY, MAY 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. M. Flinders Petrie: Discoveries in Egypt (2).

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Annual General Meeting.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—C. Tate Regan: The Skeleton of *Lepidosteus*, with Remarks on the Origin and Evolution of the Lower Neopterygian Fishes.—Dr. C. F. Sonntag: The Comparative Anatomy of the Tongues of the Mammalia. IX. Edentata, Dermoptera, and Insectivora.—S. Maulik: New Cryptosome Beetles.

WEDNESDAY, MAY 30.

ROYAL SOCIETY OF ARTS, at 4.30.—A. J. Sewell: The History and Development of the Perambulator and Invalid Carriage.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications of the Microscope Section), at 7.—M. T. Denne: An Improved Apparatus for the Production of Photomicrographs.—C. A. Newton: A New Form of Microscope Lamp for Easy Exchange of Paralleliser and Polariser.—M. P. Swift: A Hutchinson Universal Goniometer.—At 8.—J. M. Coon: The Microscopical Examination of China Clay.—H. B. Milner: The Microscopical Investigation of Sands for various Industrial Purposes.

THURSDAY, MAY 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir William M. Bayliss: The Nature of Enzyme Action (1).

ROYAL SOCIETY, at 4.30.—Dr. E. Griffiths and Dr. G. W. C. Kaye: The Measurement of Thermal Conductivity, No. 1.—Dr. G. W. C. Kaye and J. K. Roberts: The Thermal Conductivities of Metal Crystals. I. Bismuth.—C. V. Drysdale and S. Butterworth: The Distribution of the Magnetic Field and Return Current round a Submarine Cable carrying Alternating Current.—Prof. S. Russ: The Effect of X-rays of different Wave-lengths upon some Animal Tissues.—Dr. E. F. Armstrong and Dr. T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces. Part XI. The Action of Alumina and certain other Oxides in promoting the Activity of Nickel Catalyst.—N. K. Adam: The Structure of Thin Films. Part IV. Benzene Derivatives. A Condition of Stability in Monomolecular Films.—N. K. Adam: The Structure of Thin Films. Part V.—W. B. Rimmer: The Spectrum of Ammonia.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6 (Annual General Meeting).—Presentation to the Institution of (*a*) An oil painting of the late Dr. Silvanus Thompson; (*b*) Dr. Thompson's Library; (*c*) A bronze bust of Dr. Thompson, by Mr. Gilbert Bayes.

FRIDAY, JUNE 1.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—A. Kendall: The Participation of India and Burma in the British Empire Exhibition, 1924.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—The Variation of Latitude in relation to the Physical Properties of the Earth's Interior. Chairman, Lord Rayleigh. Speakers, R. Stoneley, Dr. H. Jeffreys, and others.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Dr. H. Bradley: Dictionary Evening.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. H. A. Lorentz: The Radiation of Light.

SATURDAY, JUNE 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. A. W. Hill: The Vegetation of the Andes.

BRITISH PSYCHOLOGICAL SOCIETY (at University College), at 3.—Sir Charles Walston: Some Aspects of the Philosophy of Harmonism and Future Experiments.

PUBLIC LECTURES.

THURSDAY, MAY 31.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 4.30.—Prof. L. Hill: New Ideas concerning the Biological Action of Light.

UNIVERSITY COLLEGE, at 5.30.—Prof. A. Cippico: Ludovico Ariosto (in Italian).

FRIDAY, JUNE 1.

UNIVERSITY COLLEGE, at 5.30.—Dr. P. Lang: Contemporary Swiss Literature. (Succeeding Lectures on June 8 and 15.)

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" *To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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Science and Religion.

DOES a description of the world afford any evidence of the existence of God? This is the subject of a symposium in the April issue of the *Hibbert Journal*, and the discussion has particular interest for biologists. A description of the world is not merely a statement of those conceptions that we call natural laws, but it is also an interpretation of what Prof. Whitehead calls the "passage of Nature"—the evolutionary career. In this passage the various points of view taken by the writers are these: there is an increasing enrichment of what we may call the content of Nature; there is progress; and there is an effort or striving against something.

The first interpretation is made by Dr. J. S. Haldane in an argument of sustained power. The world of our experience may be known to us through the mathematical sciences, through physics, and through biology. The conception attained through pure mathematics is *bare*; it need not include objects, and it deals typically with the space and time relationships between objects. These relations, or differential equations, need not have physical meanings. The world, from this point of view, has form but no content. To construct it out of pure extension, that is, to give all natural laws geometrical meanings, is the tendency of the later relativists; thus the world is deprived of substance, or at least, the nature of this substance is ignored. Next come the physical sciences, enriching this conception by inserting objects into the world but ignoring the plain fact that its natural laws are only working hypotheses which have limited practical meanings. They are statements of the ways in which we can *act* on our physical environment. They are descriptions of our increased power over Nature.

Then come organisms—which add something new to the world. This conclusion depends on Dr. Haldane's difference from the majority of the biologists of the last generation. "Weighed in the balance of accurate quantitative investigation the mechanistic theory of life has been found wanting." What the Victorian materialism has envisaged in the organism has been "a vista of mechanisms," one inside the other, so to speak; postulated rather than really observed; incapable of explaining organic functioning, to say nothing of reproduction and behaviour. The conception is even inadequate as a means of investigation, and it is being replaced by other methods—for example, Dr. E. S. Russell's psycho-biology. Thus mechanism fails and in this failure we recognise a further enrichment of Nature. Biology becomes a science with its own fundamental conception of life.

Lastly, there is the self-conscious human personality.

This we may consider, first, as having immediate self-interest. On the strictly mechanistic outlook, it must regard all other organisms and conscious persons merely as moving objects similar to those other objects called inorganic. But even a purely physical description of the organism is not to be obtained, and by no process called scientific can the self-conscious person explain his *own* consciousness in terms of mathematics and physics. Further, he sees other organisms that are not self-conscious, and so the mere biological life-conception fails to explain consciousness in other organisms than himself. So he is bound to make yet another fundamental conception, that of the conscious, self-interested organism; but even that is not all. Almost every action that he performs—as a member of a human community—means that he recognises *other* conscious, self-interested persons like himself: otherwise he would not seek to convince them, nor would he praise, or blame, or pity, or like, or hate them. On the purely mechanistic outlook, the things that he does, every conscious minute of his life, are meaningless.

Then, even the purely physical thing is not a unit. Anything that is known to us is known only when it changes. When it changes it does so only because other things in the physical system to which it belongs also change. In the long run, the only isolated physical system that we know is the whole universe, and it is only by convention that we arbitrarily isolate a thing from all the rest of Nature. So also the functioning and behaviour of an organism means that it is acting on, or reacting with, or adapting itself to the environment—which is the whole universe. The self-conscious person (which is also a physical thing and an organism) is only such because it reacts with other self-conscious persons. Add to this the literally true conception that all organisms, conscious or unconscious, are materially and strictly continuous in the time dimension, then the whole world is one, and personality is everywhere in it.

Thus, to the physical categories of substance, necessity, relation, modality, quantity, etc., we must add those of life, consciousness, and personality. The personality is universal in time and space and is God.

Next we have Mr. Julian Huxley's interpretation of the passage of Nature as a progress. But evolution, he sees quite well, is not necessarily a passage from the "simple to the complex." It is quite as easy to look upon the "lower" organism as more complex than the "higher" one—just because it is undifferentiated. It is plain that the morphological, evolutionary series of changes is *irreversible*, and that the goal towards which all organic races tend, as they specialise, is extinction. How, then, to define "progress"? There is a series of changes that have led up to the human race; let us attach a series of "values" to these changes, thus making a one-to-one correspondence, value to morphological change. What are the values? Those conditions judged by the human mind to have value *are* values. Progress then is the series of evolutionary changes that have *human* value, and it is, somehow, a tendency towards good. It is an obscure feeling "clarified and put on a firm intellectual footing by biology." It is true that the problems of evil, of pain, of strife, of death, of insufficiency and of imperfection remain to perplex us, but nevertheless progress is an element "essential to an externally grounded conception of God," to be incorporated into the common theology of the future.

Finally, there is Sir Oliver Lodge's interpretation of evolution as an effort: a conception which is more fundamental than any other that is touched in this discussion. Why, in the physical sense, have changes, or reactions, or events occurred at all? The answer is clear. If, by any change, a system can lose free energy or dissipate its energy, or increase its entropy-value (roughly equivalent statements), then that change will occur *of itself*. When the free energy has become minimal, or the entropy maximal, changes in the system will cease altogether. Now the only system which, in strict logic, we can consider is the whole universe. When entropy has attained its maximum value, or when all energy has become universally dissipated, all changes in the universe, all events, or phenomena (from our human point of view) will have ceased.

The world-paradox is that the universe is still the locus of change. Given an unbounded past, complete and final dissipation, with cessation of change, ought *already* to have been attained. The passage of Nature is thus towards materiality, or inertia, or passivity, but the passage is not accomplished—though it ought to have been accomplished. The world can only be the locus of activity and change because something resists, has arrested, or at least has retarded the passage towards materiality. There is an effort against inertia and this is life—the only physical conception of life that appears to be possible. There is a spiritual as well as a material passage.

Now why are there separate personalities at all? On Sir Oliver Lodge's general line of argument it may be reasoned (by analogy) that personality itself ought to exhibit a passage, or ought to be dissipated or absorbed into the universal personality, which is God. Why are they not so absorbed? Something, then, resists the ultimate dissipation of personality, just as life resists universal energy-dissipation. This something is the "invaluable but rather terrible and fearfully responsible grant" of Free Will, against which even Deity itself strives. J. J.

Sanderson of Oundle School.

Sanderson of Oundle. Pp. vii + 366 + 16 plates. (London: Chatto and Windus, 1923.) 12*s.* 6*d.* net.

FEW schools have passed through a more interesting development in modern times than Oundle. It is an old foundation and it has had periods of distinction in its long history, but its real rise to importance began in 1892 when Frederick William Sanderson went there from Dulwich to take charge. It was no light undertaking. There had been an unsuccessful period: the numbers of boys had gone down, and what was worse, the standard of work was low. Sanderson put all his tremendous energy and enthusiasm into the task and never paused till he had raised the school to its present high position. Then came his tragic death last June with the sudden break of all his plans for future development.

Some of Sanderson's colleagues welcomed the happy idea of writing down while still fresh in their minds what they knew of his methods and ideals, and these impressions have been brought together and interpreted in this book under the simple and sufficient title of "Sanderson of Oundle." The purpose was not so much to praise and honour Sanderson; it was the much more important one of saving all that could be saved of him for the world.

The task has been well done, and no man could wish for a nobler memorial. We see Sanderson entering Oundle as a young man of thirty-five—a very downright, uncompromising, and resolute personality—with perfectly definite ideas of what he wished to do and a perfectly definite intention of doing it. The development of the boy was his purpose, not the fostering of pure scholarship: if the classical method would not serve some other means must be found. To him no boy was in the first instance stupid or beyond training, though he might be made so by a wooden educational system or a stupid teacher: every boy, even the reputedly dullest, had in him a desire to make or do something—some creative instinct—and if only this could be reached the boy could be trained. So Sanderson sought to discover each boy's bent; for the ordinary boy it was used as a means of developing his mental powers; for the really clever boys full opportunities were provided for the study of their special subjects. He set up shops for wood and iron work, where real things were made (he always disliked instructional futilities), engineering, chemical and physical laboratories, biological departments, an experimental farm and an art room; he developed music. He had always the latest big thing in science on show or at work; a motor-car engine and chassis which the boys could dismantle and reassemble, an aeroplane engine for the same purpose, a big wireless set with which they could transmit their concerts, and a score of other things to awaken the boys' interest and enthusiasm.

To the purist in education it all seemed very upsetting—the multiplicity of forms, the rapid changes in books and subjects, the refined and delicate apparatus entrusted to only partly trained schoolboys. But there was method in it all. Sanderson looked on all his subjects—shops, laboratories, and sides—as so many resonators by which to test each individual boy. If he had enough resonators he could find the one to which each boy responded; and so he never hesitated to start some new side or to drop it when it no longer served a useful end. Once he found a way in to the real boy the training became easy.

But Sanderson was more than a trainer of the mind. He loved life and he wished that all might have more of it. Many of his boys were to become captains of industry in the large industrial towns. It was not enough for him that they should understand and be interested in their future work: he saw that the surest way to the enriching of their lives was to uplift it all. To him the meanest tasks of daily life had in them something divine so long as they were honourable and ministered to some need of the community, and he set himself to find this. He therefore made his workshops and laboratories serve a higher purpose than the awakening of strivings for knowledge. "I want not so much to teach engineering," he once said to me, "as to find the divineness of it." So he would never recognise the supposed conflict between science and religion or the limitations usually imposed on scripture lessons. The Bible was to him a handbook for daily life, not merely an exercise for Sundays, and he always regretted that people knew so little of it; his scripture lessons covered the whole range of human activities. He was always on the look-out for copy for them. One might be telling him of some recent development in science and he would listen with deep interest; suddenly his eyes would twinkle and he would pull out an envelope and jot down on the back some note for his next scripture lesson. He would go up to a boy working in a workshop or laboratory and ask him his views on some new thing—his own views, for all Sanderson's efforts in library, laboratory, and study were directed to the development of the boy's powers of thinking for himself. It might be relativity, the possibilities of "wireless," or something else; he would listen and encourage the boy to talk. He would then give some wider turn—probably sociological—to the conversation; for it was always his aim to train leaders of men rather than mere scholars, and he knew that no one can lead if he lacks wide sympathies.

Of late years the social or community interest became uppermost with him and he believed that the schools could do much to repair the wreckage of the War; he emphasised always the need for co-operation and pulling one's weight, for choosing the high path, for steadfast devotion to duties and leaving rights to take care of themselves.

The last evening of Sanderson's life was spent with the present writer. He had attended the Rothamsted annual function and had obviously enjoyed it. After the visitors had gone we sat talking and, as always, he soon came to his plans for the future. He was delighted that his long-desired Chapel was to be built. It was to be the centre of the school life and as beautiful and dignified as he could make it; not only with the beauty of stone: it was to be also in a wonderful garden—a miniature Kew, as he said. In the windows were to be the great calls to a high and noble life. Most of all he was delighted with Lady Scott's statue of the bright-eyed, eager-hearted, expectant boy—"Here am I, send me"—the type he wanted to send out to remake a broken world. It was the man himself speaking of his hopes and ideals, as few would care to do to another man—ideals of fulness and richness of life based on beauty and nobleness of living. For these we wished our boys to strive and so we had entrusted them to him.

Sanderson had thoroughly enjoyed life. He early found what most men desire—a great cause on which to spend himself, and to which he could give once and give all. As the years passed they had but mellowed him, bringing out his kindliness and his rich rare gift of keeping touch with youth. When the news of his death was told to the school there fell a great silence. It had been the homage given him in life when he rose to speak; it was given him now. But their abiding feeling was one of thankfulness for the life which had so truly moulded theirs, and of certainty that this was not the end. The triumphant song "Let joy and praise to Heaven rise" can rarely have been more wonderfully sung than by the boys of Oundle when he was carried from their midst.

E. J. Russell.

Civil Engineering Geology.

Elements of Engineering Geology. By Prof. H. Ries and Prof. T. L. Watson. Pp. v+365. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 22*s.* net.

The call for a smaller engineering geology than the large work issued by Prof. Ries and Prof. Watson in 1914, has led those authors to prepare an abridgment entitled "The Elements of Engineering Geology." The volume includes an account of the general principles of geology and petrology, apparently with the intention that the book should suffice for the geological needs of engineering students. It, however, includes no sections on stratigraphy or palæontology, some acquaintance with which is generally regarded as essential to a geological course in engineering. Knowledge of these subjects would be necessary to the student who would benefit by the long chapter on ore deposits.

The book may be highly recommended to British students of civil engineering owing to its clear treatment of many important problems and its instructive series of maps and illustrations, though its value to them is inevitably lessened by the fact that most of its illustrations are taken from American example and literature. The nomenclature is also American in such cases, such as "gumbo," and the use of "diabase" instead of "dolerite." The attribution of all China clay to weathering is a conclusion which is emphatically rejected in Europe. The statement on p. 90 that an oil shale to be of value should yield from 30 to 60 gallons of oil per ton in addition to ammonia, is not in accordance with experience in Scotland, where shales containing 20 gallons or even less have been profitably worked. Melting snow is said rarely to affect large streams; this is certainly not true of some large rivers in Europe and Asia, where the spring floods are due to this cause.

The authors use the unlucky term "corrasion" for mechanical excavation by rivers and "corrosion" for solution. The American use of distinct terms for the basal and lateral wear of the streams had much to commend it; but "corrasion" as in the line "wealth corraded by corruption" means to "scrape together," and corrasion was first used in the sense of corrosion apparently by a misprint. In regard to nomenclature it is also to be regretted that the authors in a book on economic geology use the term "mineral" in the sense of "mineral species" or "simple mineral" and thus exclude coal, slate, most ores, oil shale and mineral oil from the category of minerals.

The chapter devoted to the coastal topography of the United States is particularly interesting and well illustrated; the difference of the problems from those which have to be dealt with by the British coastal engineer is shown by the absence in the book of any reference to groynes. In spite, however, of the book being mainly adapted for American colleges it may be warmly recommended to British civil engineering students.

J. W. G.

Physico-Chemical Themes.

(1) *Catalysis with special reference to Newer Theories of Chemical Action: A General Discussion held by the Faraday Society.* (Reprinted from the Transactions of the Faraday Society, Vol. 17, Part 3, May.) Pp. 545-675. (London: The Faraday Society, 1922.) 9*s.* net.

(2) *Some Physico-Chemical Themes.* By Prof. A. W. Stewart. Pp. xii+419. (London: Longmans, Green and Co., 1922.) 21*s.* net.

(3) *The Theory of Allotropy.* By Prof. A. Smits. Translated from the German with the Author's sanction, by Dr. J. Smeath Thomas. (Text-books of Physical Chemistry.) Pp. xiii+397. (London: Longmans, Green and Co., 1922.) 21*s.* net.

(4) *Colloid Chemistry of the Proteins.* By Prof. Dr. W. Pauli. Translated by P. C. L. Thorne. Part I. Pp. xi+140. (London: J. and A. Churchill, 1922.) 8*s.* 6*d.* net.

(5) *Laboratory Manual of Colloid Chemistry.* By Prof. H. N. Holmes. Pp. xii+127. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 10*s.* net.

(6) *Atomic Form: with Special Reference to the Configuration of the Carbon Atom.* By E. E. Price. Pp. iv+140+viii. (London: Longmans, Green and Co., 1922.) 5*s.* net.

(1) THE Faraday Society's general discussion on "Catalysis with Special Reference to Newer Theories of Chemical Action" was apparently arranged in view of the simultaneous presence in England of Prof. Perrin, Dr. Irving Langmuir, and Prof. Arrhenius. The first session of the discussion dealt with the radiation theory of chemical action and the second session with heterogeneous reactions, and these form Parts I. and II. of the report. The discussion on the radiation theory (which postulates that chemical action is due to radiation and that its velocity is proportional to the prevailing radiation-density) was characterised by two dramatic incidents. Prof. Lindemann pointed out that, if the original form of the radiation theory were correct, the inversion of cane sugar must be determined by the density of radiation of wave-length 1·05 μ; on this basis, the inversion should proceed 50 billion (5×10^{13} times more rapidly in sunlight than in the dark), whereas actually the acceleration is almost negligible. Following up this criticism, Dr. Langmuir said that the radiation theory "has all the characteristics of the typical unsuccessful hypothesis," since it has been made progressively more complicated, as successive attempts at verification have failed. Probably no theory has ever been put forward in which discrepancies of such magnitude have appeared, and it is at least a sign of courageous optimism that the authors should still hope to bring it into line with facts.

The discussion on heterogeneous reactions was opened by a paper in which Dr. Langmuir discussed the function of the solid surface, with special reference to the occlusion of oxygen on the surface of a tungsten filament. This takes place at a temperature of 1500° K. or more, even when the pressure is so low as 10^{-6} atmospheres, or when hydrogen, ammonia, or methane is present, as well as oxygen, showing that the film of occluded oxygen is extremely tenacious. It was suggested that the stable film is of monomolecular thickness, and that the film can only be dissipated in the form of the oxide WO_3. In the same way the tenacity with which a trace of carbon monoxide will cling to the surface of platinum, acting as a powerful poison as regards its catalytic activity towards hydrogen and oxygen, is attributed to the formation of a monomolecular film of carbonic oxide united chemically with the molecules of platinum. Carbon dioxide does not behave in this way, and does not act as a poison to the catalyst. On the other hand, the normal action of the catalyst in the presence of oxygen is attributed to the formation of a film of chemically bound oxygen of higher activity than the free gas.

Experimental work on the catalytic action of platinum in the oxidation of carbon monoxide and of hydrogen formed the subject of the second paper; and the discussion which followed is reported in full, together with a number of written communications on the same subject.

(2) Prof. Stewart has added another to the series of books, in which he has summarised, mainly perhaps for the benefit of the candidate for a degree in honours, some of the results of recent chemical research. The method of handling the material in such a volume is fairly familiar, and criticism may be limited to the question as to whether the work has been well done. On the whole, the answer may be given in the affirmative, but in more than one instance the reader who is familiar with current research will feel disappointed, because some of the sections appear to have been written so long ago that they are out of sympathy with current thought, even although later work may be included either in the same or some other part of the volume. Thus to many it would appear futile to discuss the theory of the colloidal state without including any reference to the work of McBain on colloidal electrolytes, which has now been going on for something like ten years; again it is merely tedious to read through a discussion as to whether hydrogen should be placed in Group 1 or Group 8 of Mendeléeff's classification, when modern theory makes it quite

clear that this element stands in a class by itself, and need not be forced into association either with the alkali metals or with the halogens. The final chapter, on atomic structure, is remarkable in that it begins with a recapitulation of some of the fantastic ideas of atomic structure that preceded the discovery of the electron, while it concludes by dismissing Bohr's atom as "considerably overrated," and setting up in its place "Stewart's atom" as possessing merits which are not possessed by the atoms of other workers.

The various chapters of the book do, however, provide useful summaries of work which must otherwise be studied either in separate monographs or in original literature, and to those who prefer this method of assimilating knowledge the book may be commended.

(3) Prof. Smits, whose monograph on allotropy has been translated from the German, deals with a very interesting subject, namely, the application of the phase rule to those cases in which at least one of the components is capable of existing in more than one form, so that the familiar phenomena of phase-equilibrium are complicated by the occurrence of a reversible isomeric or polymeric change in this component. When the change is sufficiently rapid, the component in question counts as one molecular species; but when the change is slow, each separate form must be treated as a separate species.

There can be little doubt that if the editor of these text-books had entrusted to Prof. Findlay the work of expounding the application of the phase rule to these fascinating cases, he would have been able to tell the story in simple language, and in such a way as to interest and attract the type of student for whom these monographs are written. It is, however, certain that, while a translation of the monograph into English is a real advantage as eliminating one of the most formidable difficulties of the student, who usually finds German not an easy language to read, even the translation gives the impression that the author has deliberately made the subject as difficult as possible. One must assume that in his own teaching the author discusses these phenomena at the close of a rigorous course of training, and that those who have followed his lectures may perhaps find in the theory of allotropy a puzzle worthy of their highly developed skill; but to the student who has not gone through this training, no mercy whatever is shown, and he might well be excused for forming the opinion that Prof. Smits, like one of the old alchemists, was trying to disguise his knowledge, instead of to diffuse it, by using a bewildering system of symbols and diagrams. Almost any one of these might "hold up" the reader for many minutes, if not indeed for hours, while he was trying to discover what meaning he must attach to symbols decorated with a positive cascade of superscript and subscript signs, and thus to find out the inner meaning of the diagram. By way of further punishment, the author omits to write down the chemical formulæ of the organic compounds with which he deals, so that the student must refer to the original literature if he wishes to know what formulæ have been assigned to the two forms of benzoylcamphor, or to the various modifications of milk sugar. In this case it would appear that the author is so concerned with the mathematical dissection of these compounds in their various phases that he has no interest whatever in their chemical composition; and this view is supported by the attitude which he adopts in similar cases throughout the volume.

In conclusion, it may be said that if a keen student wishes to test his abilities by means of a volume which might well bear the sub-title, "The Phase Rule made Difficult," the book might perhaps be commended. On the other hand, the average student will probably prefer to wait for an interpreter before he attempts to study the work of an author whose desire for complexity leads him to postulate the existence of half a dozen molecular species in the simple and orderly space-lattice of a metal.

(4) Prof. Pauli's monograph on the colloid chemistry of the proteins possesses nearly all the merits that are lacking in Prof. Smits' book. Although dealing with a much more difficult subject, it has the merit of being not only brief, but also as simple as any treatise on colloids that has yet appeared. Not only those who are specially interested in colloid chemistry, but also chemical students generally, would find both pleasure and profit in reading the book, and on these grounds it can be heartily commended. It is, indeed, a particularly easy task to review a book on which none but favourable comments are possible.

(5) Prof. Holmes, at the request of the Colloid Committee of the National Research Council, has written a "Laboratory Manual of Colloid Chemistry." The total number of experiments described in the book is 186, and most of these have been tested in the laboratory over a period of six years. It is an indication of the importance that now attaches to the study of colloids that a book dealing with laboratory experiments only should be called for, and Prof. Holmes has produced a volume which every teacher of physical chemistry will find it necessary to possess. It will also be welcomed by many other workers who are not responsible for the organisation of laboratory classes in physical chemistry.

(6) Mr. Price has invented a tetrahedral model of the carbon atom which has an equilateral triangle

as section on two of its planes of symmetry, while its faces are isosceles triangles. He claims that this figure lends itself better than the regular tetrahedron to the construction of models representing the structure of organic compounds. The close packing of polyhedral figures is an important factor in crystallographic research, but, when it is not correlated in any way with crystallographic data, it cannot be regarded as of any value in the investigation of molecular structure. The author proceeds as if the carbon atoms were actually tetrahedral in shape, with real poles at the corners, whereas in fact, the tetrahedron merely serves as a convenient means of showing the directions in which the valencies radiate. It is, however, interesting to notice that the figure which Lewis obtained by concentrating four duplets on the centres of four *edges* of a cube is actually a tetrahedron of the shape described by the author, although obviously the duplets in marsh gas must occupy the alternate *corners* of a cube, since all the evidence points to the fact that methane has the full symmetry of a regular tetrahedron.

The Trend of Evolution.

The Evolution of Man: a Series of Lectures delivered before the Yale Chapter of the Sigma Xi during the Academic Year 1921–1922, by Richard Swann Lull, Harry Burr Ferris, George Howard Parker, James Rowland Angell, Albert Galloway Keller, Edwin Grant Conklin. Edited by George Alfred Baitsell. Pp. x+202. (New Haven: Yale University Press; London: Oxford University Press, 1922.) 15*s*. net.

In the chapter entitled "The Natural History of Man" Prof. Ferris gives a very lucid summary of the most elementary facts of embryology and anatomy, which suggests to the uninitiated reviewer that the Society of the Sigma Xi, for whom the lectures in this book were prepared, is a lay body unfamiliar with biological teaching. As a means of interesting such an audience in some of the manifold aspects of biology and sociology these lectures no doubt served a useful purpose, but why call the volume "The Evolution of Man"? One would imagine that in a series of six lectures with such a title some one would have discussed seriously the problems of man's pedigree, and have attempted to explain how and why the human family acquired those distinctive attributes of brain and mind which conferred the rank of mankind upon it. But there nothing of the kind is to be found in the book.

Prof. Parker gives an excellent account of his investigations on the nervous system of sponges and other animals, but the title "The Evolution of the Nervous System of Man" raises hopes that are not fulfilled; and the same remark applies to the address by the president of Yale on "The Evolution of Intelligence," as well as to Prof. Keller's "Societal Evolution." The criticism one is impelled to make of all these addresses is that, while they are interesting and illuminating, both their own titles as well as that of the book are irrelevant.

In Prof. Conklin's essay, the title of which the reviewer has adopted as the label for this notice, is a sane discussion of the trends of civilised mankind under post-War conditions and an earnest plea for education, and better education, as the remedy for the ills of society and the means of averting the downfall of the best types of mankind.

Our Bookshelf.

Department of Agriculture and Technical Instruction for Ireland. Memoirs of the Geological Survey of Ireland. Mineral Resources. Memoir and Map of Localities of Minerals of Economic Importance and Metalliferous Mines in Ireland. By Prof. G. A. J. Cole. Pp. 155. (Dublin: Stationery Office, 1922). 7*s*. 6*d*. net.

It is much to be regretted that this volume must be looked upon as the swan-song of the old regime in Ireland rather than as the first effort of the new authorities. Information as to the mineral resources of Ireland has never before been collected into any authoritative memoir, but had to be sought for piecemeal among a number of miscellaneous geological and mining publications, for, as the author of the present work correctly observes, Sir Robert Kane's book on the industrial resources of Ireland is now far too old to be of any real value under the economic conditions of the present day.

Prof. Cole has done his work extremely well; he has arranged the various minerals that Ireland produces in alphabetical order, commencing with antimony and ending with zinc. It is perhaps characteristic of an Irish publication that the most important of all mineral products, namely coal, is not even mentioned. The author states specifically that he excludes sands, clay, and marble, and devotes his attention to "minerals of economic importance"; surely coal should be included under this head. The other minerals of economic importance are very fully and clearly dealt with; the list of localities is very complete and carefully drawn up, and all the more important occurrences are briefly described. If it does nothing else, the present work will serve to dispel some of the wild statements that are occasionally heard as to the immense mineral resources of Ireland, which have been neglected or, it is even sometimes hinted, deliberately concealed, by jealous Englishmen. Among the more persistent of such legends is that of the immense resources of iron ore in the Arigna valley; the present work shows that two persevering attempts were made to found an iron industry there, at the end of the eighteenth and again in the first half of the nineteenth century, and that both ended in failure; at what appears to have been the last attempt, only 300 tons of iron were produced in seven years at a cost of 50,000*l*. A study of the entire book shows that at the moment barytes is practically the only mineral of serious economic importance that Ireland is capable of producing. Apart, however, from the strictly commercial aspect of the subject, Prof. Cole's work is of great value to the student of mineral deposits, inasmuch as it supplies authentic information concerning the mineral resources of the country.

Overzicht van de theorie en de toepassingen van gassen, waarin de onderlinge botsingen der moleculen kunnen verwaarloosd worden. Door Dr. Jos. ter Heerdt. Pp. vii + 324. (Utrecht and Nijmegen: N. V. Dekker & Van de Vegt en J. W. van Leeuwen, 1923.) 6.50 florins.

SINCE the classic researches of Maxwell on the internal friction of gases and those of Crookes on radiometer theory, no investigations have been so important in connexion with the kinetic theory of gases as the work of Martin Knudsen on the properties of highly rarefied gases, in which the mutual collisions of the molecules may be neglected. Dr. Jos. ter Heerdt has produced a very clear monograph in which the work of Knudsen and that of some other investigators, Soddy and Berry, Gaede, Langmuir, Weber, etc. (scattered in many periodicals), is brought together and critically discussed.

After a short historical introduction and some general considerations regarding the kinetic theory of gases, (Chap. I.), the author deals in the following chapters with molecular flow through narrow capillaries and small holes in plates, with molecular flow through tubes with a temperature gradient (pressure equilibrium between two reservoirs at different temperatures, connected by a capillary tube), with the molecular conduction of heat and the coefficient of accommodation. The treatment of the problem of accommodation, as given in Chap. VI., is new and throws a new light on the question. Nevertheless no general solution is given of this very complicated problem. Chap. V. deals with the radiometer force and with the formula which Knudsen has deduced for it. In Chap. VII. a full and detailed description is given of modern high vacuum pumps, based on the principles of the kinetic theory of rarefied gases (Gaede, Langmuir) and of different kinds of high vacuum manometers. The book ends with a very complete bibliography.

The volume forms a readable and clearly written monograph on a subject not covered by any existing work and may be highly recommended to all who are interested in this subject. It is to be hoped that the book, which is published in Dutch, will be translated into English, French or German in order that it may reach a wider circle of readers. C. A. CROMMELIN.

Hawaiki: the Original Home of the Maori. With a Sketch of Polynesian History. By S. Percy Smith. Fourth edition. Pp. 288 + 20 plates. (Auckland, Melbourne and London: Whitcombe and Tombs, Ltd., 1921.) 12*s*. 6*d*.

IT is most fortunate that Mr. Percy Smith was able to publish the fourth and authoritative edition of this book before his death, as it contains a considerable amount of new material and of revised conclusions. It represents the gleaning of a long life spent in amassing new data, and laboriously sifting and collating existing information. All students of oceanic ethnology owe a great debt to this painstaking, kindly, and learned pioneer. Mr. Smith entirely justifies his reliance on the general accuracy of tradition, and he has been able to give approximate dates to events in unwritten history, and also to trace three main migrations into the Pacific from Indonesia, and numerous migrations within the Polynesian area. Constructive work of this kind on imperfect material is necessarily open to criticism, but Mr. Smith courageously attempts to interpret hints and obscure words, and by imagination, controlled by intimate knowledge of Polynesian ethnology, he has made a plausible connected story, which, in his concluding words, "will in the meantime serve the purpose of a summary of the history of the people, on which others may build."

The Indian dates on p. 85 require revision. The Sâka entered the Panjab about 75 B.C., not 950 B.C.; the great colonisations of Java from India are also placed much too early; according to Havell they were due to the final collapse of the Sâka power at the beginning of the fifth century. It is important to have correct dates for events in India, as Mr. Smith uses them in the development of his thesis. The view that the Polynesians may have been in part a branch of the "ancient Gangetic race" has much to recommend it, but by terming them "Proto-Aryan" he raises very grave difficulties, but, perhaps, Pre-Aryan is what he meant to express.

This little book is invaluable to all those who take an interest in the history of the most intrepid explorers of the Pacific. A. C. HADDON.

Expressionism in Art: Its Psychological and Biological Basis. By Dr. Oskar Pfister. Authorised translation by Barbara Low and Dr. M. A. Mugge. Pp. viii + 272. (London: Kegan Paul and Co., Ltd., 1922.) 6*s*. 6*d*. net.

DR. PFISTER'S work is a study by psycho-analytic methods of a French artist suffering from depression, who came to the author for psychological treatment. In addition to the analysis of his dreams, the artist was asked to draw whatever he liked, and these drawings, usually of an extremely unconventional character, were treated in the same way as the dreams. The results are very interesting, both from the insight obtained into the personality of the artist and also from the light thrown on that type of art generally known as expressionism.

The first part of the book is a study from a psychological point of view of the artist; the second part discusses the psychological and biological background of expressionism. The author shows how excellent for diagnostic purposes were the pictures which invariably represented the artist's psychical state. From a study of the pictures of other expressionists, he concludes that all expressionists carry into their work a number of infantile characteristics. Instead of attempting to understand the external world, they turn away and represent their own internal conflicts in phantasy form, their pictures thus being in reality self-portraits. If pushed to its logical extremes, expressionism would result in an absolute rejection of the empirical world, and hence in many it tends to become pathological. The relationship between the various neurotic types and expressionists is discussed.

It is a very interesting study, both of a particular man and of an art movement; but the method of writing is discursive, and the book might with advantage be considerably condensed.

The Races of England and Wales: a Survey of Recent Research. By Prof. H. J. Fleure. Pp. 118. (London: Benn Bros., Ltd., 1923.) 5*s*. net.

PROF. FLEURE's modest claim to have given in this work a survey of recent research is an understatement which may give a misleading idea of its very real importance as a contribution to the ethnology of England and Wales—an idea which the brevity of the book does nothing to remove. It summarises in a fair and judicial spirit the results of the observations of anthropologists on the physical characters of the peoples of England and Wales, both in prehistoric and in recent times, to which Prof. Fleure himself has contributed in no small degree; but it does far more than this. It reviews these results in the light of certain general conclusions on the question of the development of racial type at which Prof. Fleure has arrived. The inferences which he has drawn in consequence cannot fail to have a profound influence on the future discussion of British ethnology as well as to stimulate observation in certain directions in the future in support or refutation of his views. Of these, perhaps the most important is that the intermediate type, which forms a common element in the population of Britain, and is usually taken to be a combination of Nordic and Mediterranean, represents in reality an independent "descent with modification" within this country from a palæolithic type.

Cryptography. By André Langie. Translated from the French by J. C. H. Macbeth. Pp. viii+192. (London, Bombay and Sydney: Constable and Co., Ltd., 1922.) 9*s*. net.

As there is no manual of cryptography in English, this book, which is translated from the French, will be welcomed by all who wish to make a serious study of the subject, either for practical purposes or as an intellectual exercise. The author deals with his subject under three heads. Under the first he gives a brief history of the methods of conveying information secretly, beginning with the Greeks, Egyptians, and Romans; under the second he gives examples of cryptographical writings of which he himself has found the solution, for the most part, during the War; and under the third he gives lists and tables of frequency of single letters, bigrams, and other combinations in English and other languages. This section will naturally be one of the most frequently consulted in the book, as a knowledge of the relative frequency of occurrence of the different letters and combinations is essential in all decipherment. The translator adds a supplementary chapter dealing with methods of conveying information secretly, such as the use of sympathetic inks, tramps' signs, the marking of cards by cardsharpers, and the like, and describes the Playfair cipher, a substitution system extensively used for military purposes, Commander W. W. Smith, United States Navy, adding a note on its solution.

Botulism and Food Preservation (The Loch Maree Tragedy). By Dr. Gerald Leighton. Pp. xiii+237. (London: W. Collins, Sons and Co., Ltd., 1923.) 10*s*. net.

DR. LEIGHTON's report on the outbreak of botulism at Loch Maree in 1922 has been already noticed in NATURE (March 24, p. 415) and some account has also been given of the comprehensive researches of Prof. K. F. Meyer, of the University of California, into the distribution and biology of the responsible microbe (January 20, p. 95). In the present volume Dr. Leighton has collected into a convenient form most of the available information about the disease as it occurs in man and animals. Originally most frequently associated with sausages and especially common in Würtemberg, most of the recent cases have been identified in America and more commonly with canned vegetables than meat products. "Limberneck" in poultry appears to be botulism, and "grass sickness" of horses is either this or a closely allied condition. Prevention is a question of the adequate sterilisation of preserved foods. The second part of the book recounts the details of the tragedy of the potted duck sandwiches and concludes with an ample bibliography.

The Annual Register: a Review of Public Events at Home and Abroad for the Year 1922. Edited by Dr. M. Epstein. Pp. xii+316+199. (London: Longmans, Green and Co., 1923.) 30*s*. net.

A WORK of reference that has reached its hundred and sixty-fourth volume requires no commendation. This annual review of the year has an established place among indispensable works of reference. English history, which appears to include Irish history, and foreign and colonial history occupy about two-thirds of the book, in a summary which is conspicuous for its impartiality and lucidity. A chronicle of events is less well-balanced but extremely useful. The year's obituary gives biographical sketches of about 300 eminent men and women of all countries. Literature of the year is dealt with in a forty-page summary, which is a comprehensive and, to a large extent, critical survey of the year's books. Science has to be content with a twelve-page summary, which, however, ranges over so wide a field that little, if anything, of notable value is omitted. A full index enhances the value of the book.

A Text-Book of Machine Construction and Drawing. By H. E. Merritt and M. Platt. Pp. x+197. (London: G. Bell and Sons, Ltd., 1922.) 7*s*. 6*d*. net.

TEACHERS of classes dealing with machine construction and drawing are frequently put to a great deal of trouble in seeking for modern examples to put before their students. Text-books on the subject go out-of-date, and on account of the great strides which have been made in recent years in the manufacture of engineering materials, and in their treatment in the machine shop, and consequently in design, details have shown an increasing tendency to become obsolete. The volume before us contains a large number of designs suitable for students, and all of these examples are up-to-date. The authors make use of the American system of projection, and there is sufficient practical geometry included for the purposes of the draughtsman.

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.*]

Dr. Kammerer's Alytes.

THOSE who have followed the discussion of Dr. Kammerer's claims will be aware that special interest has centred on the question whether he could produce for examination males of Alytes showing the modification alleged to occur in consequence of his treatment. Some of the circumstances which aroused scepticism are related in my letter to NATURE, July 3, 1919, p. 344. We were originally told (*Arch. Entwm.*, 1909) that nuptial callosities or *Brunftschwielen* appeared on the thumbs of males of the treated strain, and that in the 5th treated generation (Kammerer's F_4) *all* the males had these structures. They are a conspicuous feature in most Batrachia, and Alytes is one of the few forms in which they are not known to occur. Since normal Alytes mate on land and the treated animals were made to pair in the water, we were asked (1909, pp. 516-7) to see in these *Schwielen* a true functional adaptation. The rugosities were developed to give the males a better grip of the slimy females.

Dr. Kammerer remarks that any one who has compared the feel of a dry toad with that of a wet one will not question that rugosities on those parts of the limb which come into contact with the body of the female are a very necessary equipment for an aquatic embrace (p. 516). This theme was developed at considerable length. In *Arch. Entwm.*, 1919, the same argument reappears, and, various other hypotheses being discussed and set aside, it is argued that the most probable cause of the development of rugosities was to be found in the change of mating habits. The process of mating in the water takes twice or thrice as long and is far more laborious. If his interpretation is right, Dr. Kammerer continues, the development is to be regarded as a "*funktionelle Anpassung*: ihre nachweisliche Erblichkeit würde hierdurch an theoretischer Tragweite gewinnen" (p. 339).

Up to 1919 nothing but vague diagrams (1909, Figs. 26 and 26*a*) had been offered us to show what these new organs looked like, and no detailed description had appeared. Dr. Kammerer in that year published the long paper mentioned above, making some new statements which I will consider presently. In illustration a photograph of the whole animal (F_5 in 1913) was given. This picture was rather like those handed about a few years ago as "spirit-photographs," and for demonstrational purposes was worthless. There were also several drawings, and a photograph, representing sections through the skin of a supposed *Schwiele*. At about that time Dr. Przibram was good enough to send me a slide with six similar sections labelled "F_3," which I have shown to numerous colleagues. As regards the sections and representations of sections, I do not question that they may have been taken through real incipient rugosities, but the development is slight and ambiguous.

The description of 1919 amplifies that of ten years before. The rugosities were originally described as in the proper place, namely, on the upper (sc. dorsal) and radial surface of the thumb; and as more males of F_4 and F_5 came into breeding condition, rugosities appeared not simply on the bases of the thumbs but extended in various degrees and with individual differences up the inside of the forearm. Inasmuch as various Batrachians have rugosities in that region (showing also individual differences and asymmetries), and since in the embrace of Alytes the parts named are in contact with the female, the new account raised no fresh improbability—rather the contrary. Many modified males are said to have been under Dr. Kammerer's observation during three years after he had (1910) been challenged to produce one, but a photograph of a single specimen—and that absolutely non-committal—was all that had been published to show the structures in position. We are told that the 1913-hatched brood failed to breed, and the last male (F_6) died in 1914 (1919, p. 328).

But one specimen (presumably that photographed) was known to be preserved in Vienna. It had been examined by visitors to the Versuchsanstalt, who reported verbally and variously as to what they had seen. A few weeks ago the announcement was made that this Alytes would be shown in Cambridge, and I received an invitation to attend a meeting at which it would be exhibited. Knowing that Dr. Kammerer had abstained from appearing at the Congress of geneticists which met at Vienna in September last, I inferred that he had no new evidence to produce, and I therefore excused myself from attendance, not wishing to enter deliberately into what was likely to prove a profitless altercation. When, however, an exhibition before the Linnean Society was arranged, I naturally attended as a fellow of the Society to see what I could. I expected to see a dark mark on the thumb or other fingers extending perhaps more or less over the wrist or up the forearm; and whether this was to be interpreted as a nuptial rugosity or not, would, I imagined, be more or less a matter of opinion.

What I did see was something altogether different. The animal was fastened with its back against an opaque plate in a cylindrical museum glass, with the ventral surface exposed. The right hand showed nothing special, but *across the palm* of the left hand was a broad dark mark. It looked like a piece of thickened, blackish-brown skin. Examining it with a good lens I could see no papillary or thorny structure, though considering the minuteness of the alleged spines, I scarcely expected to make them out very distinctly. But the appearance was quite unlike that of any natural *Brunftschwielen*. In them, even in *Rana agilis* which has them developed very slightly, one sees with a lens characteristic grey specks, not a dark uniform surface as in the creature exhibited. I do not mean that there was no break in the pad as a whole, about which my memory is doubtful, but that the surface was uniform and the colour continuous in tone, without the dotting or stippling so obvious in true *Brunftschwielen*. That there was no development on the right hand was explained. The skin had been snipped off during life to furnish sections.

A photograph of the palm of a hand was thrown on the screen. This palm was pointed to as showing rugosities, but I saw none. In the specimen exhibited, the backs of the digits were not visible, nor were we shown any photograph of them.

I direct attention first to the fact that the structure shown did not look like a real *Brunftschwiele*. Next I lay stress on its extraordinary position *It was in the wrong place*. Commenting on the evidence, I pointed this out. In the embrace of Batrachians the palms of the hands of the male are not in contact with the female. Those who looked at the specimen naturally concluded that they must be. One speaker confidently told me in the discussion that I was wrong, and that in the common toad the rugosities *are* on the palmar surface! To show how the hands are placed I send a photograph (Fig. 1) of a pair of *Rana agilis* killed and preserved while coupled. The lower digits of the male's hands are the thumbs.

Clearly the rugosities, to be effective, must be on the backs and radial sides of the digits, round the base of the thumb, as in our common frog, on the inner sides of the forearms, or in certain other positions, but not on the palms of the hands. There are,

Fig. 1.

of course, minor variations, in correspondence with which the positions of the rugosities differ. The clasp of Alytes, for example, is first inguinal and afterwards round the base of the head (Boulenger). Minute thorns may be formed on the back of Bombinator and perhaps in other places on the skins of Batrachians, where they cannot serve as *Brunftschwielen*; but on the palm of Alytes they would be as unexpected as a growth of hair on the palm of a man.

Dr. Kammerer's own reply was on different lines from that of the speaker I have mentioned, but curious and, as I thought, significant. He asked us to note that in his lecture he had refrained from using the word "Adaptation"—a defence sound perhaps, though surely disquieting to his disciples.

The discoveries claimed by Dr. Kammerer are many and extensive. To geneticists that regarding heredity and segregation in Alytes (*Verh. naturf. Ver.* Brünn, 1911) which I called in question at the Linnean meeting is the most astounding. But what I then heard and saw strengthens me in the opinion expressed in 1913, that until his alleged observations of *Brunftschwielen* in Alytes have been clearly demonstrated and confirmed, we are absolved from basing broad conclusions on his testimony.

W. Bateson.

May 16.

The Light Elements and the Whole Number Rule.

I have recently developed a method of generating anode rays of high velocity which is much more suitable to mass-spectrum analysis than the hot anode method previously applied. By means of this device it is possible to obtain the mass-lines of the metals of the lithium and beryllium groups at the same time as those of such elements as carbon and chlorine, the masses of which are known.

The masses of Li^6, Li^7, Be^9, Na^{23}, Mg^{24}, K^{39}, K^{41}, Ca^{40} have all been determined, and the divergence from whole numbers is in no case so great as one-tenth per cent. of the mass measured. The masses of the isotopes of lithium are most probably about 0·005 of a unit high, but naturally this figure does not have much significance with the present apparatus.

The effects with magnesium and calcium are too weak to show their fainter components, but the integral relations between these and the principal lines have already been demonstrated by Dempster. (Phys. Rev. xviii, xx.)

This work completes the determinations of the masses of the more important isotopes of all the first twenty elements on the mass-spectrograph, and, with the obvious exception of hydrogen, each obeys the whole number rule to the accuracy of experiment, one part in a thousand.

It is of particular interest that no difference in mass is detectable between the isobaric atoms Ca^{40} and A^{40}, for general considerations might lead one to expect a radical difference in their nuclear structure owing to the presence of the two additional nuclear electrons in the latter.

F. W. Aston.

Cavendish Laboratory,
Cambridge, May 17.

Microphonic Flames.

[A few weeks ago it was reported in the daily Press that Dr. Lee de Forest had used a flame for the direct production of telephonic currents by sound waves In response to a request for details of his device, Dr de Forest writes as follows.—Ed. Nature.]

I have as yet prepared no paper on the subject of the "microphonic flame." For a long time I had puzzled over the problem of turning sound waves *directly* into electric telephonic currents. I recognised that sound waves passed through flames in the air; also that a flame was, to a certain degree, conducting electrically. Hence, I reasoned that if one passed a current through a flame, its conductivity *must* vary, more or less, with the alternate waves of compression and rarefaction, which constitute sound.

Setting out to verify my deductions, I succeeded almost at once. I employed first a "bat-wing" gas-flame, enriched this with potassium salts, used two platinum wire electrodes across a dry cell battery of 100 to 200 volts, in series with a high-resistance (radio) telephone receiver. By carefully adjusting the electrodes in the flame (especially the *cathode*—the position of the anode is not important; it can even be located a short distance *outside* the flame) I obtained in the telephone receiver a faint but *very perfect* reproduction of the music of a gramophone played 3 ft. from the flame. The adjustment of the gas pressure, using this type of flame, is critical. If too strong, the flame roars in the telephone receiver. If too low, the conductivity and sensitiveness of the flame falls off.

I next employed a type of Welsbach burner and mantle, using as electrodes platinum gauze "imbedded" in the mantle and directly inside the mantle. Also, an oxy-acetylene flame, employing for electrodes platinum wire *encased* in quartz, which, of course, becomes conducting in this flame. This arrangement gives an exceedingly perfect reproduction of the sound—voice or music—far better than any carbon microphone.

A small alcohol burner and flame can be employed. In this case I recommend as cathode a Nernst glower as supplying the necessary electrons. Or enrich the blue flame by potassium or sodium salts fed up through the wick, with the alcohol.

Audion amplifiers must, of course, be employed if one wishes to use the "flame microphone" for broadcasting, radio-phone, or "phonofilm" purposes.

The sensitiveness increases in general with the impressed P.D. across the electrodes—up to a limit.

Care must be taken to guard against: (1) hissing due to too high voltage discharge; (2) flame noises; (3) air fluctuations; (4) depositing of carbon upon the electrodes.

I have not had time yet to make a careful scientific study of this phenomenon, but am persuaded it is chiefly a *pressure* effect, controlling ionisation and the ionised conductivity of the flame.

LEE DE FOREST.

Molecular and Crystal Symmetry.

MR. T. V. BARKER has discussed in NATURE of May 12 the theory advanced by Fedorov and Shearer with reference to the relations between molecular and crystal symmetry. According to this hypothesis the symmetry of the crystal includes the symmetry of the molecule with such additional symmetry as is afforded by the arrangement of the molecules, if there be more than one, in the unit parallelepipedon or cell of the structure.

At the reading of Mr. Shearer's paper I mentioned some considerations which required to be taken into account in applying this principle (Proc. Phys. Soc., vol. 35, p. 99, 1923), and I propose to restate them here in somewhat more detail.

In many cases there is reason to believe that molecules have no existence in the structure of a crystal. In others they appear to maintain their identity. It does not, however, follow that they retain the full symmetry they possess when in the free state in a fluid; for the whole or a part of the symmetry may be destroyed by close packing in the crystal structure. Nor is it probable that the symmetry actually possessed by the unit cell formed of one or more molecules is always identical with that of the structure of which it forms part.

In the first place, a number of primary cells with different but similar orientation (including in this expression a symmetrical relation between enantiomorphic forms) may be combined by what may be termed cell-twinning to form a greater cell with higher symmetry. These greater cells may of course be regarded for crystallographical purposes as unit or elementary cells; but it is improbable that they would always be recognised as such by means of the X-rays, which would in many cases not permit of discrimination between the differently orientated primary cells. The same crystallographic characters would also result from ultra-microscopic twinning on a larger scale, involving groups of differently orientated cells instead of individual cells. Repeated ultra-microscopic twinning of this character is believed to take place with the triclinic mineral microcline, so as to give rise to the monoclinic mineral orthoclase.

Apart, however, from regular twinning, one would expect cells of low symmetry to build up in many instances structures of higher symmetry, but usually belonging to the same system. Perfect identity in cells is not necessary in the building up of a structure. A plagioclase crystal is formed of cells both of albite and of anorthite, with quite distinct atomic composition, and even to a limited extent of orthoclase which differs both in system and in molecular volume. Where, therefore, the outward forms of cells of the same substance in different orientations (in the wide sense employed above) closely resemble each other but do not show absolute identity, it may be expected that the crystal structure will be built up indiscriminately of cells with similar but not identical orientation. The result will be that the special features characteristic of a lower symmetry will be eliminated and only the highest symmetry of the system will remain. This is probably the reason why crystals possessing the symmetry of one of the lower classes of a system are comparatively rare, and in some instances are not known to occur.

These principles are well illustrated by the facts disclosed in a paper on the "Relation between the Crystal Structure and the Constitution of Carbon Compounds, Part I., Compounds of the Type CX_4" (Journ. Chem. Soc., vol. 123, pp. 71-79, 1923), by Miss Knaggs, of the Imperial and Bedford Colleges. She shows that in substances of the CX_4 type, where X is an element, the crystal usually belongs to the cubic system. Those of the type CX_3Y, where X and Y are elements, are as a rule trigonal or hexagonal, unless X is hydrogen, the atoms of which appear to be too small to determine a trigonal symmetry. Those of the form $C(CX_3)_4$ are usually cubic, as the trigonal character of the CX_3 group enables all four trigonal axes of the cubic system to be preserved. Finally, substances of the form $C(CX_2Y)_4$ are in general tetragonal. In every case in which the symmetry of the crystal shows it to belong to the same system as that of the molecule, it must be referred to a higher class, usually that with the highest symmetry in the system. For example, the molecules CX_4 and $C(CX_3)_4$, which are cubic, have no axial planes of symmetry, but wherever there is any definite crystalline form, the crystals possess such axial planes. In some cases, however, the cubic system is only recognised by the isotropic character of the crystals. Again it can be easily shown that the molecule $C(CH_2Y)_4$ belongs to a class of the tetragonal system with only a contra-directional or inverse tetragonal axis, but the crystals have all a co-directional or simple tetragonal axis, such as is found in the higher classes of the tetragonal system.

In many cases, on the other hand, there are isomorphic forms with lower symmetry, formed usually at lower temperatures. In these the atoms are apparently more tightly packed, and the molecules have either been distorted or have lost their identity altogether.

JOHN W. EVANS.

Imperial College of Science and Technology,
South Kensington, S.W.7,
May 15.

IN a recent letter to NATURE (May 12, p. 632) Mr. T. V. Barker takes exception to statements made by the writers in respect to the relation between the symmetry of a crystal and that of its components (G. Shearer, Proc. Phys. Soc., 1923, vol. 35, p. 81, and W. T. Astbury, Proc. Royal Soc., 1923, vol. 102, p. 506). It appears to us that his criticisms are based on certain misapprehensions.

Fedorov tried to prove (*Zeits. Kryst.*, 1912, Vol. 52, p. 22) that if n is the symmetry number of the structural unit of the crystal, or, briefly, the crystal unit, or, in other words, is the number of identical or enantiomorphously related asymmetric parts into which it is subdivisible, if m is the number of molecules it contains and p the symmetry number of each molecule, then $n = mp$. Mr. Barker believes that Fedorov failed to prove his case, that the first paper referred to above contains an unconscious repetition of Fedorov's argument, which, though new evidence is brought forward, is still unconvincing, and that the suggested structure for tartaric acid is against the principle and not, as we have said, in its favour.

In the first place, Fedorov's statement was surely unexceptionable in the form in which he made it. If one of the molecules, or groups of molecules into which the unit is divided, possesses a plane of symmetry, this can mean only that it has similar relations with its neighbours on either side of the plane and through them with the rest of the crystal. That is to say, the plane of symmetry of the molecule is also a plane of symmetry of the crystal. On the other hand, we must be ready to allow, as Sir William Bragg has pointed out, that a molecule as built into a crystal may not have the same form as the freer molecule of a liquid or a gas. Such a difference seems to occur in the case of tartaric acid, on which account the crystal and its solution differ in their optical properties. The molecule may have a plane of symmetry in one case and not in the other. It is a task of the future to correlate the forms and the symmetries of the molecule in its different conditions. It is by no means improbable that the differences are small (Journ. Chem. Soc., 1922, vol. 121, p. 2766). Fedorov was quite aware of this possibility himself. If Fedorov's statement is taken to refer to the molecule as built into the crystal, it seems to require no further defence.

In the next place, the rules or principles set out in the first of the two papers referred to do contain Fedorov's statement, no doubt. If the author had been aware of the paper he would have referred to it. But the essence of the statement which is criticised is not an enunciation of a law of crystal symmetry which could not have been and was not overlooked by the searching examination of the crystallographers. It was an attempt to codify certain results of X-ray analysis. Fedorov could say, rightly as we think, that a crystal of the monoclinic prismatic class could be formed of four groups, A, B, C, and D: of which B was obtained from A by reflection across a plane, C by digonal rotation about an axis, and D by inversion through a centre of symmetry. He had no direct evidence to carry him further. The X-rays do go further: they show that in the crystal unit of benzoic acid, for example, there really are four groups so related to one another, and they give their relative positions. Moreover, they show that each of these groups is, in substance at least, the chemical molecule. This is new knowledge, which could not be proved by Fedorov. If it had been in his power to do so, the crystallographic tables would have contained the dimensions of the unit cell of each crystal; and not merely, as they do now, the topical ratios.

We may point out that Mr. Barker is in error also in supposing that nothing can be said about the symmetry of the molecule until the position of every atom in it is accurately determined. The X-rays show that the molecules of benzoic acid, for example, are divisible into two groups, which present exactly the same aspect when viewed along the axis of the crystal and different aspects when viewed in any other direction. This is in agreement with the hypothesis that the two are the reflections of each other across the plane of symmetry, and that each is by itself asymmetric with respect to that plane.

Lastly, Mr. Barker refers to the structure of tartaric acid, described in the second of the two papers, as an infringement of the principles set out in the first, because, as he says, it has an "unobtrusive dyad axis," which does not coincide with the axis of the crystal. The only answer is that it has not, as may be seen from Figs. 8, 12, 14, 15 of the paper, or more easily from the model itself. There is no such axis, and, therefore, no infringement.

G. Shearer.
W. T. Astbury.
Physics Department,
University College, London.

The Mechanism of the Cochlea.

In Mr. Wilkinson's letter in Nature of May 12, p. 636, three points are raised upon which I wish to comment.

For the sake of simplicity I described the mechanical conditions occurring when sound waves reach the cochlea in the normal manner by the chain of ossicles. In the case of bone conduction the mechanism of analysis ought to be the same as under other conditions. Bone conduction is the response to a continuous series of uniform waves from a tuning-fork which would produce a corresponding series of vibrations in a resonating system. I cannot agree that the movement "originates *at the basilar membrane*," because the movement depends on the whole resonating mechanism, including the inertia and friction of the fluids.

Damping is the decrease in amplitude due to resistance, and I believe that by using that term Mr. Wilkinson intends to deny any influence due to liquid friction in affecting the note to which the system resonates. In White's "Handbook of Physics" (Methuen and Co., first edition, p. 305), I find "partly closing the mouth [of a resonator] lowers the note." This is an example of friction in a gas affecting the frequency of resonance, which is also seen in the well-known method of tuning organ-pipes. If such an effect is shown with a gas, surely it must be much greater with a liquid in such narrow tubes as those of the cochlea.

With reference to the spiral ligament, I think that the point is unimportant. I merely pointed out the danger of deducing from the size of the ligament the tension on the membrane at rest. To make the point clearer I would suggest the analogy of the size of a pair of hooks supporting a cable. The size of the hooks may not be designed with reference to the tautness of the cable. The cable may be slack, so that the only pull may be that due to its weight; but large hooks may be used, because the cable may have to sustain heavy weights from time to time. I am quite willing to believe that the fibres of the basilar membrane near the *fenestra ovalis* may be more tightly stretched than those near the apex of the cochlea, but that does not necessarily follow from the dimensions of the spiral ligament.

Finally, I wish to emphasise that this correspondence arose in relation to the dimensions of the cochlea and the possibility of such a small structure acting as a resonating mechanism. The point that I wished to bring out was that, on account of its small size, liquid friction will be very great and that this friction may be *one* of the factors in the analysis.

H. E. Roaf.
London Hospital Medical College,
Turner Street, Mile End, E.1,
May 15.

An Einstein Paradox.

THE following, with amplified details to help discussion, is, I trust, a fair statement of the problem in Einstein's "Relativity" (Methuen). K, K_1 are together, each provided with a clock. The clocks agree at noon when K_1 starts moving in a straight line with uniform speed v (*estimated in K's units*).

Some time later, a light signal is flashed from a point L on the line, ahead of K_1, and is seen by K, K_1 at times t, t' on their respective clocks; $KL=x$ of K's units of space and $K_1L=x'$ of K_1's. Then, according to Einstein,

$$(1)\ \ldots\ x'=(x-vt)/\sqrt{1-v^2/c^2},$$
$$(2)\ \ldots\ t'=(t-vx/c^2)/\sqrt{1-v^2/c^2},$$

where c = vel. of light *in vacuo*.

Since (1) does not contain t' we shall avoid the comparison of clocks by considering that equation only.

Now let us take the case of $x'=0$; *i.e. let the light signal be made exactly when K_1 reaches L.*

Then by (1), $t=x/v$.

But x/v is the time on K's clock when K_1 reaches L; to this must be added the time for light to come from L.

Therefore true value of $t=x/v+x/c$.

Hence (1) appears to be fallacious.

In that case, also, $x^2-c^2t^2$ is not equal to $x'^2-c^2t'^2$.

It is remarkable that Einstein actually considered the case of $x'=0$, but overlooked the interpretation of it.

It may be interesting, possibly instructive, to consider how a "Newtonian philosopher" would deal with the above problem as soon as he became aware that the velocity of light was not negligible. There are three cases.

1. As above—the signal *ahead of* K and K_1, then

$$t=\frac{x-x'}{v}+\frac{x}{c}=\frac{(c+v)x-cx'}{cv},$$
$$t'=\frac{x-x'}{v}+\frac{x'}{c+v}=\frac{(c+v)x-cx'}{v(c+v)};$$

whence

$$t'=\frac{c}{c+v}t \quad \text{and} \quad x'=(1+v/c)x.$$

2. The signal *from behind* K, K_1, so that x, x' are negative:

$$t=\frac{x-x'}{v}+\frac{(-x)}{c}=\frac{(c-v)x-cx'}{cv},$$
$$t'=\frac{x-x'}{v}+\frac{(-x')}{c-v}=\frac{(c-v)x-cx'}{v(c-v)},$$

equations which, as might be expected, are deducible from the previous pair by writing $(-c)$ for c.

3. The signal *from between* K, K_1; or x positive, x' negative:

$$t=\frac{x-x'}{v}+\frac{x}{c},$$
$$t'=\frac{x-x'}{v}+\frac{(-x')}{c-v},$$

whence no neat results.

It seems reasonable to conclude that *no single pair* of equations, such as the Lorenz transformation, can meet all the cases!

R. W. GENESE.

40 London Road,
Southborough, Kent.

Longevity in a Fern.

I WONDER what is known of the duration of life in common herbaceous plants, other than annuals and biennials? The following instance may serve as a contribution to the lore of the subject.

About the year 1872 I found on the Mendip Hills a mature specimen of that curious sport of the hart's-tongue known as *Scolopendrium vulgare* var. *perafcrum-cornutum*, in which the mid-rib and the lamina part company at the apex of the frond, the mid-rib projecting as a horn, and the lamina forming a frilled pocket on the anterior surface. I transferred it to my father's garden in the same neighbourhood, where it has flourished ever since, retaining its peculiar character.

In 1917, as it was in danger of being choked by the growth of surrounding shrubs, I transplanted it. The stock had twice divided dichotomously, forming three crowns, of which one was dead. I placed the living ones where they had room to grow, and now they are as vigorous, and as young in appearance, as the original plant fifty years ago. As the plant was of unknown age when found, and looks no older after fifty years, its capacity for life seems indefinite.

F. J. ALLEN.

Cambridge, May 3.

The Recording Ultramicrometer.

THE recording ultramicrometer was first very briefly described before the Royal Dublin Society (Royal Dublin Society, xvi. p. 185, March 1921; *cf.* also NATURE, June 23, 1921, vol. 107, p. 523). Since its exhibition at the Edinburgh meeting of the British Association many short accounts of it have appeared in England and abroad. Many correspondents have requested further information, and, as some time may elapse before a full account of my investigations in this connexion are published, I take this opportunity of giving some practical hints to enable others to set up the apparatus.

In Fig. 1 the three-electrode valve is connected to

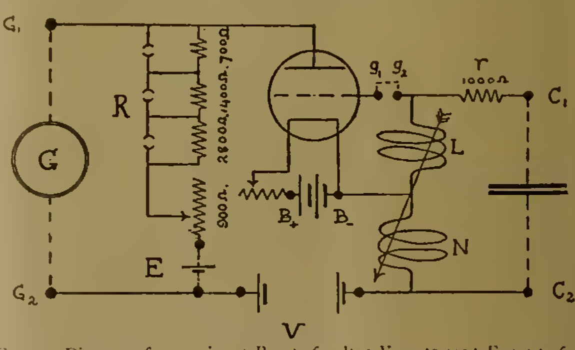

FIG. 1.—Diagram of connexions: B, 4 to 6 volts; V, 30 to 100; E, 1.5 to 6. L, N, about 10 cm., flat, 150 turns. G, aperiodic galvanometer, 10^{-8} amp. per div.

an oscillation circuit of the "Hartley" type, and in the anode circuit a sensitive galvanometer is introduced, its terminals being shunted by the "zero-shunt" E, R. The condenser C_1 C_2 of the oscillation circuit is formed by two parallel metal discs (say 5 cm. diameter). One of these may conveniently be adjustable by a fine micrometer screw, so that the capacity can be altered by turning the latter. As the plates are screwed together, increasing the capacity, it will generally be found that, from a certain point, the anode current increases, reaches a maximum, and finally rapidly recedes to its original value.

This sequence of changes takes place only when the circuit can oscillate. To follow the complete sequence it is necessary either to shunt the galvanometer heavily or to substitute for it a milliamperemeter.

A set of observations so obtained is given in Fig. 2, which represents the apparatus in the best adjustment for our purpose. To obtain this linear form of curve

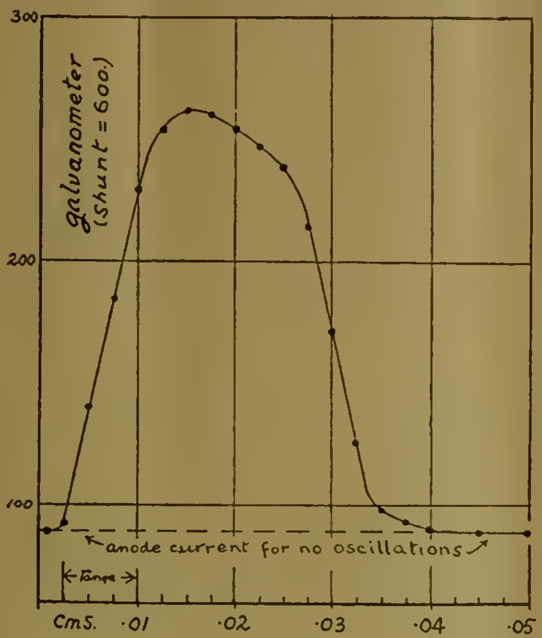

Fig. 2.

the relative positions (" coupling ") of the coils must be altered, and the most suitable plate voltages (V) ascertained by trial. With some valves it may be necessary to apply a negative potential to the grid between the points g_1 g_2, Fig. 1. I have used several common makes of " R Type," hard valves, and have never found any difficulty in obtaining the condition shown.

The function of the " zero-shunt " is to by-pass an amount E/R of the anode current j, so that, if R is large compared with the resistance of the galvanometer, the current through the latter is approximately j – E/R. When E and R are chosen so as to make this difference small, a sensitive galvanometer can be employed, unshunted, which will then give large deflexions, when the plates of the condenser suffer minute displacements. In view of the *linear* form of the curve (Fig. 2), it will be clear that the galvanometer reading is proportional to the plate displacement. Also, calibration is readily obtainable by shunting the galvanometer, say ten times, and then observing the deflexion obtained when the micrometer screw is turned through, say 1/1000 cm.

A resistance r up to 1000 ohms may be introduced into the oscillation circuit to reduce the sensitivity and widen the range of the plate movement. This resistance also renders it easier to obtain the linear adjustment. The large black dots in Fig. 1 represent the terminals on the case of the instrument; the batteries, galvanometer, and condenser plates are external and are connected to these terminals. The actual resistances, coils, etc., are mounted beneath the ebonite top of a small box, about one foot square and a few inches deep. Rigid connexions are employed to eliminate vibrational effects.

In the use of the apparatus for recording small displacements, movements, etc., one of the condenser plates is caused to partake of the movement to be measured by direct attachment, if possible, to the moving member. The other plate may be mounted, as already described, on a micrometer screw device to facilitate calibration. For steady working, at all times great care must be taken to employ batteries that are in perfect condition, and have an adequate current capacity. It is advisable to use cells of the same type for E as for V. Temperature changes must naturally be avoided in view of expansion and other effects. For " super " sensitivities (above 10^{-7} cm.) screening and other precautions become necessary.

John J. Dowling.

University College, Dublin, May 7.

A Permanent Image on Clear Glass.

The interesting observation described by Mr. Eric Robinson in Nature of April 28, p. 569, and commented upon in the same issue by Dr. J. W. French, is an excellent example of the ease with which the surface of glass may suffer modification and retain it over a long period of time. The present writer has studied a number of phenomena connected with " breath figures," and an account of the work will be found in the *Philosophical Magazine* for October last.

If the tip of a small blowpipe-flame is drawn rapidly across a sheet of glass it can be shown in various ways that the surface of the glass along the flame-track has been considerably modified. Flames of coal-gas, carbon monoxide, and hydrogen produce identical results. When moisture from breath condenses on the glass it is in the form of a misty deposit of minute hemispherical droplets, except along the flame-track, where it collects as a continuous transparent film. The contrast between the two types of condensation is most marked and constitutes a " breath figure." These flame-tracks are revealed when silver is chemically deposited upon the glass and they can also be traced by the greatly increased friction which manifests itself when a chemically cleaned watch-glass, which is being dragged across the plate, encounters one of the tracks. The insulation of the glass surface is also less along a flame-track than it is on those parts which have not been exposed to the action of the flame.

It is not possible in the space available to give the evidence in favour of the conclusion reached by me that at least two causes operate in producing the modification of the glass surface which leads to a " breath figure." One of these is that the flame removes the extremely thin film of contamination which certainly covers all glass which has not been subjected to a rigorous chemical cleansing process, and the other is probably a physical change in the surface of the glass itself. The latter is very persistent and can be detected for many months after the passage of the flame across the glass. I am inclined to attribute Mr. Robinson's effect to a physical change in the glass surface. Is it not possible that the gelatin of a photographic print which has been squeegeed upon glass may, when dry, exercise a considerable force on the surface in contact with it and that this force may have different local values depending upon the density of the photographic image? Such local differences in tension may impress upon the glass corresponding differences in surface structure which would then be capable of detection as a " breath figure " or by deposition of silver.

T. J. Baker.

King Edward's School, Birmingham,
May 7.

The Transmission of Speech by Light.[1]

By Prof. A. O. RANKINE.

IN 1880 Graham Bell devised a system of using light for transmitting sounds, including speech, and called his instrument the "photophone." This system afterwards experienced a chequered career, having attracted only occasionally the attention of other investigators, with the result that, although considerable improvements have been made, it has until quite recently remained a novelty. It is beginning, however, to enter upon the phase of practical use, more particularly in connexion with some of its applications in which the distance over which the light acts as the vehicle plays no essential part. In these circumstances it is, perhaps, desirable to introduce some modification of nomenclature. There is little doubt that Graham Bell's original idea was to transmit speech by means of a beam of light which travelled over as great a distance as possible. It is true that the maximum range he records having attained is 700 feet. The modesty of this achievement perhaps prevented him from introducing the notion of distance into the name he gave to the apparatus. Now, however, the name "photo-telephony" would appear to be appropriate for the improved system which, with its increased efficiency, and with the aid of modern amplifying devices, has a range of transmission of several miles and the immediate prospect of such extension that the earth's curvature will prove in practice to be the limiting factor. The adoption of this name for telephony by light would have the additional advantage that it would leave us free to retain the equally appropriate term "photophone" for those special modifications, already mentioned, in which distance is an unimportant consideration.

If we wish to use light for the transmission of sounds it is clear that we must impose on the light features which are characteristic of the sounds in question. The plan generally adopted is to modulate the intensity of the light in accordance with the vibrations constituting the sounds. How this is done will be considered later. For the moment the question is by what means these fluctuations of intensity can be made to reproduce audibly the original vibrations. This reproduction is possible because we have at our disposal certain substances, of which suitably prepared selenium is the best-known example, capable of acting as electric valves operated by variations of illumination. Selenium is not ideal for the purpose. Indeed, having regard to its many defects, it is surprising that it functions so well as it does. Shelford Bidwell, in a Friday evening discourse at the Royal Institution in 1881, spoke of the "capricious behaviour" of selenium, and it has to be admitted that this is still a fair description, even though many improvements of design and efficiency have been introduced by various makers of so-called selenium cells. There are, for example, obscure changes of conductivity, occurring slowly, which have defeated all attempts to use the electrical conduction of selenium as a basis in photometry.

Fortunately, these relatively slow changes are not of appreciable importance in connexion with the photophone, for in that case the fluctuations of light intensity are very rapid, corresponding, as they do, to audible frequencies. A more objectionable feature is that there is displayed a considerable lag in the electrical valve action, which prevents its operation being at all efficient, especially when the selenium is called upon to respond, as in the photophone, many times a second. If a suitable substitute free from this inertia-like effect could be found it would very soon displace selenium cells and the similar devices at present in use. Of the latter a notable example is the "thalofide" cell of T. W. Case, which is quicker than selenium in its response, but is sensitive to infra-red radiation rather than to visible light, and cannot be exposed to bright light without suffering deterioration in its photo-electric properties.

It is not proposed here to describe in detail the transmitting and receiving devices employed in speech transmission by light. The writer has, in a previous issue of NATURE,[2] already given some indication of the lines of development. With regard to the modulation of the light by speech two general plans have been adopted, namely (1) to cause the speech vibrations to control the actual candle-power of an artificial source of light, and (2) to use the voice to actuate a mechanism which interrupts in the appropriate manner a beam of light after it has left a constant source. Graham Bell's transmitter was of the latter type, and, although until recently the tendency, particularly on the continent, has been to employ the former plan by superimposing on the current in an electric arc or suitable filament lamp the microphonic currents arising from speech sounds, it is now fairly generally recognised that greater efficiency can be attained by improved forms of the interruption method. This method has also the advantage that it can be applied to any source of light, and thus brings into our service sunlight, which is the brightest of all.

The simplest form of the receiving device is a circuit consisting of a selenium cell, an electric battery, and a telephone receiver. On exposure of the selenium to constant illumination, a constant, or, at any rate, a very slowly varying current passes. If, however, the illumination is of a fluctuating character—if, in particular, the variations are those due to modulation by speech vibrations—the selenium is able, in spite of its lag, to control the current in a closely corresponding manner, so that the diaphragm in the telephone receiver, through which this current flows, is set in vibration, and emits sounds resembling with a remarkable degree of accuracy the original sounds used in modulating the light. The speech currents in this simple circuit can be transformed into other circuits if desired, and they can be amplified in the usual way by means of thermionic valves. It only has to be borne in mind that selenium cells are usually of very high resistance, and that, therefore, methods of transformation appropriate to such cases should be employed.

It is easy to arrange the optical system of the transmitter so that the light projected is confined to a very narrow angle and directed upon any small chosen

[1] From two lectures delivered at the Royal Institution on April 12 and 19.

[2] NATURE, vol. 104, p. 604 (1920).

area in the distance. The amount of light received by the selenium, placed, as it is, near the focus of a lens or mirror of definite aperture, diminishes, of course, as the distance is increased. Several factors determine the range of efficient transmission—the intrinsic brilliancy of the light source, the dimensions of the optical parts, the sensitivity of the selenium, and the number of stages of amplification which are used. No very conclusive tests of the maximum range of the photo-telephone have yet been carried out; it may, nevertheless, be asserted with some confidence that, given sunlight and modern amplifying devices, it is probably the earth's curvature which would impose a limit on the range of an instrument of quite reasonably small dimensions.

It is of interest to compare the photo-telephone with the system of wireless telephony now so commonly used in broadcasting. In both, waves in the ether constitute the fundamental basis; the medium is the same and the speed of propagation is the same. In both, speech vibrations modulate the intensity of the energy transmitted, and in both the results are made audible by changes of current in the receiving apparatus. The details are, of course, dissimilar. The radio-frequency waves are produced artificially, and are under control as regards wave-length; the luminous waves are taken as we find them emitted from the source. The detectors—the valve or crystal on one hand, and the selenium cell on the other—are not strictly comparable. But the only really important difference lies in the lengths of the waves. Roughly, the radio-frequency waves commonly employed are one thousand million times as long as those operative in photo-telephony. This difference is of great importance in relation to the mode of propagation. Wireless waves at present in use are so long that they turn readily round corners, so that not only does the earth's curvature impose no serious limitation of range, but broadcasting in all directions is possible and, indeed, inevitable. Light waves, on the other hand, are for practical purposes propagated rectilinearly; consequently photo-telephony can never be expected to attain a very great range. It has, however, the compensating feature that by its directiveness it implies not only secrecy of communication but non-interference by simultaneous transmissions, without the necessity of tuning as in radio-telephony. It is true that selenium is more sensitive to red light than to other colours, and is therefore somewhat selective as regards frequency, but the suppression of the other colours is not called for, and would, in fact, be a disadvantage.

The photophone, as distinct from the photo-telephone, has several other applications. Two may be briefly indicated. The modulated light from the transmitter can be focussed into a narrow line upon a uniformly moving kinematograph film upon which, after development, there appears a band of varying opacity corresponding to the light fluctuations, and, therefore, to the speech or other sounds used for modulating purposes. The same film, on being run at the same speed between a source of light and a selenium cell with a suitable optical arrangement, gives a reasonably good reproduction of the original sounds. With sufficient amplification the results can be heard proceeding from a loud-speaking telephone. The application of this form of gramophone to the problem of synchronised pictures and sounds is obvious, and has been described in an earlier article.[3] Many workers in various countries are now concentrating their attention upon perfecting a system of this kind, and there is no reason to suppose that realisation will be long delayed.

The speech currents controlled by selenium under the action of the modulated light from a photophone transmitter compare favourably in accuracy of form with those obtained by means of a carbon microphone. The photophone as a whole—*i.e.* the transmitter and receiver together regarded as one unit—can thus be used as a substitute for the microphone in cases where stricter accuracy in electrical sound transmission is desired. This necessity has arisen in acute form in connexion with radio-telephony, in which the radio-frequency oscillations have to be modulated in the transmitting valve as nearly as possible in accordance with the sounds it is desired to transmit. A photophone has been used successfully at the Manchester broadcasting station for this purpose, and for some months those who listen to this station have been receiving the results of what can quite fairly be described as a remarkable sequence of occurrences. A singer sings, and the aerial vibrations thus created fall upon a diaphragm. This is forced also into vibration and imparts its motion to a small mirror, which in turn deflects a beam of light so that more or less of it reaches a selenium cell. By its photo-electric property the cell controls an electric current so feeble that it has to be amplified by thermionic valves in several successive stages before it is intense enough to modulate efficiently the radio-frequency oscillations in the transmitting valve. Thence the modulated wave travels through the ether to the receiving aerial; here, perhaps, it undergoes one or more high-frequency magnifications, and then the modulations are detected by a crystal or valve. Then there may be several low-frequency amplifications before, eventually, the fluctuating current actuates a telephone diaphragm causing it to re-create those aerial vibrations which we hear. When we bear all this in mind our attitude is not that of criticism of the defects of reproduction, but rather that of amazement that it so closely resembles the original.

[3] NATURE, vol. 108, p. 276 (1921).

Recent Experiments in Aerial Surveying by Vertical Photographs.[1]

By Prof. B. MELVILL JONES and Major J. C. GRIFFITHS.

II.

COMPILATION OF THE MOSAICS.

THE compilation of the mosaics presents considerable difficulties unless approached in a systematic manner, for, although individual prints fit well together, there are always some slight errors which tend to accumulate, unless special precautions are taken to prevent this occurring.

We begin the compilation by laying out each strip of photographic prints separately, paying special attention to the joins between successive prints. Slight

[1] Continued from p. 709.

changes of height, either in the aeroplane or the ground, will cause slight changes in scale between successive strips, and slight persistent tilts, either in the camera or the ground, will cause the strips, as fitted in the first place, to show fictitious curvatures due to differences being represented to a larger scale on one side of the strip than on the other.

To make a good fit between successive strips, these fictitious curvatures and differences of scale must, so far as possible, be eliminated by distributing errors between all the joins of the individual prints. We do this by securing to the back of the strips lengths of stretched elastic, fixed to each print in one spot by dabs of seccotine, and, when all the strips have been so treated, we lay them side by side upon a table and stretch and bend them systematically, until we have got the best general fit that can be obtained, without detail handling of the separate prints.

FIG. 1.—Photographic map of $7\frac{1}{2}$ by 15 miles, showing the elastic bands used in the compilation. In the finished map the prints would be properly trimmed and the elastic bands removed.

Provided that the strips were originally taken in fairly straight lines, this process of systematic adjustment appears to eliminate the fictitious curvature almost entirely and to adjust the relative positions, even of points that are far apart, with remarkable accuracy. A final adjustment is then made, in which attention is given to each print separately, but no print is moved far from the position that it has taken up in the systematic adjustment. Fig. 1 shows a mosaic laid out in this way. Notice the straightness of the strips due to the gyroscopic control, which was used in this case.

ACCURACY OF THE MAPS.

Two mosaics of $7\frac{1}{2}$ by 15 miles have been compiled in this way, without any reference whatever to existing maps. Some 40 points were selected on each of these, and their positions on the mosaic plotted on transparent paper. A plotting of these same points was then taken from the Ordnance map and enlarged until the best possible fit could be obtained with the points from the mosaic. The two plottings were then slid over each other until the best fit was obtained, and thus the remaining discrepancies give a measure of the distortion of the mosaics, without regard to scale.

The first of these mosaics was made without the gyro control on the rudder; it contains an area of 10 miles by 5 in which no point is displaced by more than 100 yards, but outside this area, towards the ends, there are points displaced by as much as 250 yards.

In the second mosaic, which is the one illustrated in Fig. 1, the gyro rudder control was used, and in this mosaic there is no distortion greater than 100 yards in any part. The increased accuracy is due, mainly, to the greater straightness of the runs, and to the pilot having been able to give more attention to maintaining height and speed constant.

The average scale of both mosaics came out to 1/19,800 as against 1/20,000 intended. The difference of 1 per cent. may be due either to the aeroplane having been about 100 feet too low, or to errors introduced during the systematic adjustment.

COMPILING TO CONTROL POINTS.

Our next experiment was to start again with new prints and to compile these two days' work together into a single 15-mile square. But this time, instead of fastening the ends of the elastics down to the table, we fastened them to laths on the edges of the table. (See Fig. 2.) The object of this was to enable us to apply systematic strains to the mosaic as a whole, after the first systematic adjustment, to cause it to fit control points.

We chose four control points, forming a rough 10-mile square, and, assuming their positions to be independently known (in this case from the Ordnance map), constructed a template to fit them, upon a scale that would most nearly fit the corresponding points upon the mosaic, after its first adjustment. We then applied this template to the mosaic and found that, owing to the distortion of the latter, displacements of about 150 yards were necessary at each control point to obtain an exact fit. These displacements were given to the mosaic by moving the laths as a whole, so that the adjustments were distributed over all the joins. The mosaic was then given a final adjustment in detail and the prints stuck down in place after removing all the elastics. When this work had been completed, some 40 points, distributed over the surface of the mosaic, were measured up and compared with the Ordnance map, and it was found that there were no errors of more than 60 yards, except on the extreme northern edge of the part of the mosaic that was made without gyro control on the rudder. In this region errors up to 130 yards were recorded.

The scale to which the template had to be constructed came out at 1/19,930. The difference between this scale and that of the separate mosaics compiled from the same photos was possibly introduced during the systematic adjustments.

a good measure of control between very widely spaced ground-surveyed points. If, for example, the photos in these flights be taken at exactly equal time intervals and the positions of the ends of the strips be known, the centre of each intermediate photo could be determined with considerable accuracy.

We have in hand experiments upon a scheme for using these indication strips, together with a few long strips at right angles, to control the positions of the 10-mile square units. We estimate, on good but not yet conclusive evidence, that, representing these preliminary strips by elastic bands and stretching the frame so formed to fit control points, we could so distribute the errors that the 100 square mile units mosaics could be located in position within ¼ to ½ a mile, even when the control points are spaced as much as 50 miles apart. It will be noted that this method of locating position is unaffected by the presence of hills.

FIG. 2. Showing method of compiling the 15-mile square photographic map to fit four control points. The prints are hidden by the weights used to hold them in place after their final adjustment, but the white elastic bands to which the prints are fastened are clearly shown. The black elastic bands were added to facilitate systematic straining at right angles to the direction of the strips.

VARIATIONS OF HEIGHT.

The country of which this map was made contains local differences of level up to 300 feet in several places and on the extreme southern edge rises to 500 feet above the lowest part.

NAVIGATIONAL CONTROL.

In some types of country, control points even of 10-mile spacing may not be economically obtainable. The complete absence of control points would not, as we have seen, seriously affect the accuracy of the individual mosaics as regards distortion, but it may leave their average scale in some doubt. There may, therefore, be some difficulty, in these circumstances, in fitting the mosaics together and in controlling their relative positions. It will be remembered, however, that it was necessary, for the identification of the starting points of the mosaic strips, to begin a survey by laying down identification strips spaced 10 miles apart. The most economical way to do this, when mapping over large areas, would be to commence by laying down a series of long parallel strips 10 miles apart having a convenient length of, say, fifty miles. If care is taken to fly these indication strips very straight and at a constant speed, it may be possible to use them to give quite

We do not recommend using control points so widely spaced as this, but we are concerned to show that the mosaics could be located with moderate accuracy even when the control points are so far apart.

The methods upon which experiments are in progress would not be limited to use with control points forming any particular pattern; they could be used with any form of triangulation. If, however, triangulation is impracticable, as it may be in flat wooded country, we are informed that astronomical methods, carried out on the ground, with the help of wireless time signals, can be used to locate position within 100 to 200 yards. If this method could be employed, therefore, in conjunction with aerial methods, it would be possible to push accurate mapping into unsurveyed country in which the ordinary ground-surveying methods, based on triangulation, are impracticable.

TRAINING AND EQUIPMENT.

The methods that we have described require considerable skill and special training on the part of the pilot and observer. If they are not adequately trained the probabilities are that the strips of photographs that they produce will be badly curved and leave gaps between them, while the individual photos will be tilted up to about 6 degrees and taken from varying heights. In such circumstances accurate compilation is almost impossible unless a map already exists, and, even then, re-section and re-projection of individual photos will be necessary if anything but the roughest results are to be obtained. The gaps that have been left between strips will, moreover, have to be filled up; and, as this is not an easy operation, several additional flights may be necessary for a satisfactory completion of the mosaic.

We are, for these reasons, definitely of the opinion that to employ crews that are not specially practised in the work is to court certain failure; at least in the earlier stages, before experience has been gained.

Special equipment, such as gyro rudder controls, etc., is, in our opinion, necessary for continuous successful work at the rate we have indicated, namely 100 square miles a day. Should the gyros break down in the field, it would be possible to carry on for a time in the absence of any gyroscopical aid, but the strain on the pilot would be so greatly increased that his work would deteriorate seriously unless he confined himself to considerably less work than we have indicated for a single flight.

It is also important to use a stable aeroplane, having adequate accommodation for the observer and his camera and for the pilot's special instruments. We have ourselves used a tractor (D.H. 9a), but we consider that a pusher would be far more satisfactory on account of the better view downwards, sideways, and forwards.

Summary.

We have shown that it is possible to carry out aerial surveying by vertical photographs at the rate of 100 sq. miles to the day's flying. When working in moderately flat country the results so obtained can be worked up into 100 square mile mosaics which, when reduced to a suitable scale, will fit a true map within 100 yards at all points. If so desired these maps can be adjusted to fit any number of control points with very little extra labour. If these control points are spaced about 10 miles apart, the absolute error of any point on the mosaic should be less than 100 yards, but, if more closely spaced control points are available, the errors can be reduced, reaching a limit of something less than 20 yards, when the spacing is reduced to one mile.

If the available control points are spaced more widely than 10 miles apart, a measure of control can be provided from the air by navigational methods. We estimate that, even when the control points are spaced so far apart as 50 miles, we could in this way control the position of the 100 square mile units within $\frac{1}{4}$ to $\frac{1}{2}$ mile. We are working on this problem at present.

The maps can be made throughout from contact prints off original negatives, no re-projection of individual photos being necessary.

Triangulated points, forming any convenient pattern, can be used as control points; *e.g.* previously existing primary, or secondary, triangulations could be used.

The methods are dependent on there being sufficient detail visible on the photos to allow them to be joined correctly; they would not be practicable on absolutely featureless deserts or prairies.

Specially trained, picked crews using suitable aeroplanes, specially equipped, are necessary for success.

Obituary.

Col. G. F. Pearson.

On April 25, Col. George Falconer Pearson died at Kington, Herefordshire, aged ninety-six years. He was one of the last, if not the very last, of devoted servants of the Crown who joined the Indian service some time before the Mutiny, and became a distinguished pioneer of systematic conservancy of the Indian forests.

Pearson commenced his service in the 33rd Regiment of the Madras Light Infantry in 1846, in which he became adjutant, and he also acted for some time as A.D.C. to Sir Herbert Maddock. He happened to be on leave at home when the Mutiny broke out, but returned at once to India and joined his regiment in the Central Provinces, where he was employed in the chase of Tipoo Sahib and other rebels. After the Mutiny he raised a force of military police, 600 strong, with which he put down general lawlessness in the province.

Having thus become well acquainted with the extensive forests and the various tribes living in and around them, Mr. Temple, the Chief Commissioner, appointed Pearson the first Conservator of Forests of the Central Provinces in 1860. Pearson, being endowed with an iron constitution and great energy, devoted the next eight years to the organisation and administration of the 20,000 square miles of Government forests in the province, selecting and demarcating reserves, introducing a system of regulated utilisation, starting a successful method of protecting the forests against the annually recurring forest fires, and regulating shifting cultivation; in other words, substituting a regular system of management for the method of reckless devastation of the past. His success brought him the special thanks of the Government of India for his valuable services.

In 1868 Pearson was transferred to the charge of the forests in the North-west Provinces, where he reorganised the department, estimated the yield capacity of the forests, and opened out the hill forests by the construction of roads, bridges, and timber slides, by which large quantities of timber were brought down to the plains for railway construction. In 1871 he was appointed to act for Dr. Brandis as Inspector-General of Forests, and in 1872 he left India to take up the appointment of director of studies to the British forest probationers at Nancy, a post which he held until 1884. On his final retirement he settled at Kington, where he lived for thirty-nine years, being a J.P. and the friend of all classes of the inhabitants.

Pearson, though not specially educated as a forester, energetically absorbed and utilised the leading principles of rational forest conservancy, and took a great part in the introduction of a system of rational forest management in India. He recorded his experiences and ideas in numerous reports, and he published a book on his "Reminiscences" of his activity in the Central Provinces. He was a great judge of character, and he succeeded in becoming the friend of those who served under him, while stimulating them to energetic action similar to his own. While at Nancy, he overcame in a short time the difficulties which had sprung up before his arrival, and his influence upon the students was highly beneficial; in return they loved and admired him. His younger son is a distinguished member of the Dehra Dun Research Institute.

Capt. C. H. Ryder.

News has come from Copenhagen of the death of Capt. Carl Hartvig Ryder, director of the Danish Meteorological Service, on May 3. He had been known to be suffering from rheumatism for some years and lately to find the cares of his official duty onerous; but, to us, the news of his death has come quite unexpectedly.

The Danish Meteorological Office is justly famous for the early production of Daily Weather Charts of the Atlantic Ocean, 1873 to 1876, by Capt. Hoffmeyer, sometime director, a work which was continued by the Danish Meteorological Office and Deutsche Seewarte jointly from 1881 until 1911, with the interval of August 1882 to August 1883, which was covered by the maps of the London Meteorological Office. In 1921 the International Committee expressed the desire for the charts to be brought up-to-date and Capt. Ryder had promised his aid. Further, with its relations to Greenland and Iceland, Denmark is one of the guardians of the farthest North, and for many years the Danish Meteorological Office has compiled all available information about ice in northern waters and published with great promptitude year by year reports thereupon.

Capt. Ryder, a naval officer, was appointed director in 1907 on the death of Paulsen. He became a member of the International Meteorological Committee in 1910 and was an indefatigable and most helpful member of that body, especially in regard to weather telegrams from Iceland. By nature he was disposed to work out meteorological progress on conservative lines: he realised that there was still much to be done in improving the data without which there are no adequate means of testing theories. His presence at future international meetings will be sadly missed by his colleagues.

Napier Shaw.

We regret to announce the following deaths:

Dr. D. Duncan, formerly director of Public Instruction in India and principal of Presidency College, Madras, and biographer of Mr. Herbert Spencer, on May 18, aged eighty-three.

Dr. Hans Goldschmidt, the originator of the process for the preparation of chromium known by his name and of thermite, a mixture of aluminium and oxide of iron, used for welding iron and steel, and also in incendiary bombs, on May 20, aged sixty-two.

Prof. G. L. Goodale, professor of botany at Harvard University from 1878 until his retirement as emeritus professor in 1909, and president of the American Association in 1890, on April 12, aged eighty-three.

Prof. Immelmann, general secretary of the German Röntgen Society, in Berlin, on April 1, aged fifty-six.

Dr. A. Looss, formerly professor of parasitology in the School of Medicine, Cairo, a distinguished helminthologist, on May 4, aged sixty-two.

Mr. M. de C. S. Salter, superintendent of the British Rainfall Organisation, on May 21, aged forty-two.

Prof. A. G. Webster, professor of physics, Clark University, Worcester, Mass., known for his work on acoustics, aged fifty-nine.

Current Topics and Events.

We learn from the Paris correspondent of the *Times* that the celebrations of the centenary of the birth of Pasteur commenced on May 24 with a reception by the French President at the Elysée. On the following day the principal ceremony was held at the Sorbonne, where a plaque was unveiled which bears an inscription recording the meeting between Pasteur and Lister in the Sorbonne on December 27, 1892. This tribute was arranged by the Association France-Grande Bretagne. A visit was paid by the President and the Minister of Education to Pasteur's birthplace at Dôle on May 26. M. and Mme. Vallery-Radot, descendants of Pasteur, have presented a bust of Pasteur, which was unveiled in the Galerie des Glaces at the Palace of Versailles on May 28, and the French President is to unveil the Pasteur monument at Strasbourg on May 31. A kinematograph film tracing the principal events in the life of Pasteur and giving a general idea of his scientific work was exhibited on May 24 to more than 3000 school-children in Paris, and considerable sums in aid of French laboratories have been collected by the sale of Pasteur badges in the streets. A new French 10-centimes postage stamp bearing the effigy of Pasteur engraved by Prud'homme has been issued to mark the occasion of the centenary. We hope to publish later an account of the celebrations by one of the British delegates.

As recorded in our columns, the late Arthur William Bacot, entomologist to the Lister Institute of Preventive Medicine, one of the most brilliant and original investigators in the field of medical entomology, lost his life a little more than a year ago in the course of an experimental inquiry into the rôle of the louse in the transmission of typhus. Several of Mr. Bacot's friends and colleagues have thought that some memorial of him ought to be established in the village where he resided and, before his appointment to the staff of the Lister Institute, carried out important medico-entomological researches. Mr. Bacot entered the ranks of specialist investigators from those of amateur naturalists and Nature students, and always attached the greatest importance to the teaching of Nature study in the elementary schools. His colleagues and friends believe that the form of recognition which would have been most congenial to his feelings would be the provision of assistance to the authorities of the Council schools in his home (Loughton) in furthering the study of natural history. With that object, a fund has been opened—the Bacot Memorial fund. It is proposed that the interest on any money received—to be invested in the name of trustees chosen by the subscribers—should be devoted to the purchase of such pieces of simple apparatus such as collecting boxes, specimen cabinets, etc., necessary for the development of Nature study in a school. It is well known that in the present state of public finances it is difficult to obtain grants for such purposes from educational authorities, and that the availability of even a very small income makes a great difference to an enthusiastic teacher. Should any of Mr. Bacot's friends or admirers of his work who feel in sympathy with the proposal care to subscribe to the fund, subscriptions will be gratefully acknowledged either by the hon. treasurer, Mr. Hubert Baines, Bryn Mawr, Church Hill, Loughton, Essex, or by Dr. Major Greenwood, National Institute of Medical Research, Hampstead, N.W.3.

THE Jonas Laboratory for the mechanical testing of metals and the Edgar Allen Laboratory for magnetic investigations at the University of Sheffield were formally opened on May 3 by Sir Oliver Lodge. These laboratories have been equipped by means of two gifts of 5000*l*. each from the late Mr. Joseph Jonas and the late Mr. Edgar Allen respectively, accommodation being found in the existing buildings of the Applied Science Department of the University of Sheffield. The equipment of the Jonas Laboratory includes Armstrong-Whitworth machines of 85 and 50 tons capacity, with oil-pump and accumulator and a variety of extensometers, an Izod machine, and a new instrument for the detection of early slip in metals by electrical means. Special equipment for the study of fatigue has been provided, including a Haigh machine for alternating tension and compression, a modified Stromeyer machine for alternating torsion, and a modified Wöhler machine, the latter two having been designed and constructed in the department, and provided with optical devices for short-period tests. The instruments for the measurement of hardness include the ordinary Brinell machines, the small Brinell machine for tests with balls of small diameter, a scleroscope, sclerometers, and the Herbert pendulum instrument. There is also a series of instruments, optical and other, for determining the accuracy of standard gauges. The Edgar Allen Laboratory is specially equipped for investigations on the magnetic properties of steels and other alloys, and has been designed and arranged by Dr. T. F. Wall. Current of various voltages, direct and alternating, is supplied by cables to distributing boards around the room, and a special generating set has been installed for obtaining alternating currents of variable high frequencies. A powerful electro-magnet, capable of producing very intense fields, has been constructed in the department. The electrical instruments include a Duddell oscillograph, a variety of measuring instruments, vacuum thermo-junctions for small alternating currents, standard condensers and resistances, and magnetic instruments (Epstein square, fluxmeter, etc.). The equipment of this laboratory is exceptionally complete. On the occasion of the opening, a number of visitors inspected the laboratories, and Sir Oliver Lodge delivered an address on the value of research work in industry.

To commemorate the fiftieth anniversary of the foundation of the Institution of Electrical Engineers (under the name of the Society of Telegraph Engineers), the Council decided in 1921 to establish a Faraday medal in bronze to be awarded not more than once a year for "notable scientific or industrial achievement in Electrical Engineering, or for conspicuous services rendered to the advancement of Electrical Science, without restriction as regards nationality, country of residence, or membership of the Institution." The Council selected for the first award of the medal Mr. Oliver Heaviside, who, unfortunately, owing to ill-health, was unable to attend a meeting of the Institution to receive the medal, which was personally presented to him by the then president, Mr. J. S. Highfield, at Torquay on September 9, 1922. The second award of the medal was made by the Council to the Hon. Sir Charles Parsons, at the ordinary meeting of the Institution held on Thursday, May 10. Mr. Highfield, past-president, said that the name of Sir Charles Parsons stood first in the engineering world of to-day, and that there was, he thought, no one who did not know what a mighty work Sir Charles had done for the engineering of the last thirty or forty years. His name would be remembered in connexion with the design and development of that great engine for the production of power which we know to-day, the turbine. After Dr. S. Z. de Ferranti had also spoken of the work and of the great benefits that had come to the world as the result of Sir Charles Parsons's invention, the president, Mr. F. Gill, presented the Faraday medal to Sir Charles. In making the presentation, the president expressed the wish that Sir Charles would live many years in which to enjoy the very special position of regard and affection of all members of the Institution.

SUMMER time commenced in France on Saturday last, May 26, at 11 P.M.

SIR ARTHUR KEITH will deliver the twelfth biennial Huxley lecture at the Charing Cross Hospital Medical School on Wednesday, June 27, at 3 o'clock. The subject will be "Recent Advances in Science and their bearing on Medicine and Surgery." No tickets of admission will be necessary.

PROF. W. D. BANCROFT, professor of physical chemistry in Cornell University, New York, will deliver an address entitled "A Plea for Research" at the house of the Royal Photographic Society, 35 Russell Square, W.C.1, on June 5 at 8 o'clock.

BY the will of Sir James Dewar, who died on March 27, the University of Cambridge is to receive all his scientific apparatus in the chemical laboratory of the

University, and, similarly, the Royal Institution will receive all his apparatus in the Institution and the laboratory attached to it.

ON Wednesday, June 6, the Anglo-Batavian Society will entertain Dr. H. A. Lorentz, professor of physics in the University of Leyden, at dinner at the Langham Hotel, London, W., when Sir Walter Townley, chairman of the council of the Society, will preside. Among the guests who have accepted invitations for the dinner are Lord Haldane, Sir Frank Dyson, and Sir William Bragg.

EXAMINATION of candidates for the Associateship of the Institute of Physics will be held in London at the latter end of September next. Applications for entry must be received before June 30. Forms of application and copies of the papers set in 1922 can be obtained from the secretary, 10 Essex Street, London, W.C.2.

IT is stated in the *Times* that a wireless station is to be erected on Novaya Zemlya Island by the Russian authorities. The station will be situated by Matochkin Strait and will be in communication with North Russian and Siberian stations. The personnel will include, in addition to the wireless experts and meteorologists, a geologist and a zoologist.

THE seventy-ninth general meeting of the Institution of Mining Engineers will be held at Glasgow on June 12-14, and among the papers to be presented are "Coal-dust as an Explosive Agent," by Mr. G. H. Rice, and "The Recent Search for Oil in Great Britain," by Mr. H. P. Giffard. A summary will be submitted of the research work carried out for the committee on the control of atmospheric conditions in hot and deep mines. Excursions to collieries and works in the neighbourhood of Glasgow have been arranged.

AT the April meeting of the Franklin Institute, Philadelphia, the Howard N. Potts gold medal was presented to Dr. Albert W. Hull of the Research Laboratory, General Electric Company, Schenectady, New York, for his paper on "The Crystal Structure of the Common Elements," and the Edward Longstreth medal was presented to a representative of the Société Genevoise d'Instruments de Physique of Geneva, Switzerland, for the universal measuring machine produced by the company.

THE Association of Economic Biologists will hold its annual field meeting at Cambridge on Friday, June 15. The programme includes visits to the School of Agriculture, where investigations on animal nutrition and physiology will be demonstrated; to the National Institute of Agricultural Botany, where will be shown the field trials of agricultural crops, and to the University Farm and Plant Breeding Institute to see the investigations in progress on cereal hybridisation.

THE trustees of the Ramsay Memorial Fellowships for Chemical Research are prepared to consider, at the end of June, application for not more than two fellowships, one restricted to candidates educated in Glasgow. The fellowships, which are each of the annual value of 250*l*., plus a grant of not more than 50*l*. yearly for expenses, are tenable normally for two years, but they may be extended to three years. Applications must be sent by, at latest, June 15, to Dr. W. W. Seton, University College, Gower Street, W.C.1.

AT the annual general meeting of the Linnean Society held on May 24, the following officers were elected: *President*: Dr. A. B. Rendle; *Treasurer*: Mr. H. W. Monckton; *Secretaries*: Dr. B. Daydon Jackson, Dr. W. T. Calman, and Capt. J. Ramsbottom; *Other Members of Council*: Dr. W. Bateson, Dr. G. P. Bidder, Mr. R. H. Burne, Prof. F. E. Fritch, Prof. E. S. Goodrich, Dame Helen Gwynne-Vaughan, Sir Sidney F. Harmer, Dr. A. W. Hill, Mr. L. V. Lester-Garland, Baron Rothschild, Dr. E. J. Salisbury, Mr. R. J. Tabor, Mr. T. A. Sprague, Prof. F. E. Weiss, and Dr. A. Smith Woodward.

IT is stated in the *British Medical Journal* that the Ontario Legislature has established a research chair for Dr. Banting, the originator of the idea that diabetes might be controlled by extracts of the islands of Langerhans, for which the name "insulin" had been suggested by Sir Edward Schafer a good many years ago, and under which it has now become a commercial product. The income of the chair, to which Dr. Best will act as assistant, will be 10,000 dollars a year. Dr. Banting intends to be present at the discussion on diabetes in the Section of Medicine at the annual meeting of the British Medical Association in Portsmouth.

THE first attempt to broadcast a picture by wireless telephony was made on May 24 at the London Station of the British Broadcasting Co. The experiment was made by Dr. Fournier d'Albe, who used a special code method adapted to a juvenile audience of "listeners-in." It being Empire Day, the picture chosen for broadcasting was a portrait of King George V. The picture was coded by dividing it into thirty horizontal strips and splitting up each strip into twenty squares. A letter was assigned to each square to indicate its average shading, and these letters were written out in thirty lines of twenty letters each. Each line was divided into four groups of five letters, and each group was dictated into the microphone in turn. The lines were numbered, so that mistakes could be easily avoided. The total time of transmission, with instructions, was twenty-two minutes, but it was found that the code message itself could be taken down in eight minutes. The picture was reproduced either by graduated dots on squared paper or on an ordinary typewriter, using letters of graduated size and making the line space equal to the letter space. Recognisable reproductions were made in from twenty to twenty-five minutes. In the complete method a special typewriter or "dot-writer" is to be employed.

NEWS has reached Copenhagen of the progress of Mr. Lange Koch's expedition to north-west Greenland. The *Times* reports that Mr. Koch wintered at Upernivik on Baffin Bay and in March 1922 left for

Cape York, where his survey began. He continued his work to about lat. 82° N., but was forced to abandon his project of charting Peary Land. A large tractor proved very useful for transport, and easily pulled over snow a sledge loaded with food supplies and ten barrels of petroleum. After several hundred miles it broke down and had to be abandoned. Progress then became difficult. A bad epidemic of influenza in the Cape York district has caused such heavy mortality among the Eskimo that it is impossible at present to start any expedition from that base. Mr. Koch intends to return to Denmark in the course of the present summer.

The arrangements for the International Air Congress to be held in London at the Institution of Civil Engineers, Great George Street, London, S.W.1, on June 25-30, are now approaching completion. The papers to be presented cover every field of aeronautical development, and are thoroughly international in character, as contributions have been received from America, Belgium, Denmark, France, Holland, Italy, Spain, and Sweden, among other countries, in addition to Great Britain. Applications for membership of the Congress will be accepted up to Saturday June 9. A number of visits to various Government experimental and research establishments and Royal Air Force Stations have been arranged, and several of the leading aircraft and engineering firms have expressed their readiness to receive members of the Congress at their works. Communications regarding the Congress should be made to the International Air Congress, London, 1923, at 7 Albemarle Street, London, W.1.

Bulletin 54 S issued by Messrs. Watson and Sons (Electro-Medical), Ltd., Sunic House, 43 Parker Street, Kingsway, London, W.C.2, is a descriptive list of second-hand X-ray and electro-medical apparatus which the firm has for sale. Complete units for X-ray work are offered, in addition to numerous accessories, such as induction coils, Coolidge filament transformers, mercury interrupters, X-ray tubes, screens, and so on.

The Medical Supply Association, Ltd., of Gray's Inn Road, London, now supply "Radio-Wave" receiving apparatus of all kinds, from a "junior" crystal set, up to a "Radio-Wave Plutocrat" receiver with a range of 300 miles. Modern radio sets are now so simple that no special education or skill is required to work them. Some of the sets also can receive the roughest usage without damage. The receivers made by the Association are of the approved type and the valve apparatus supplied is fully licensed. The lengthy list given of radio parts in their catalogue will be welcomed by amateurs.

Messrs. Longmans and Co. have in the press, for appearance in their series of "Manuals of Telegraph and Telephone Engineering," "The Inspection and Testing of Materials, Apparatus, and Lines," by F. L. Henley, which will describe the methods employed in the British Post Office in the inspection and testing of supplies of the various materials used in line construction, cables, telephone and Morse telegraph instruments, and furnish the inspector with a basis of sound information upon which to form a judgment in those cases where electrical, mechanical, or chemical tests are either not available or are not conclusive. In the same publishers' "Rothamsted Monographs on Agricultural Science" will appear "Manuring of Grasslands for Hay," by Dr. Winifred E. Brenchley of the Rothamsted Experimental Station.

Our Astronomical Column.

The Diameters of Saturn's Satellites.—Major P. H. Hepburn contributes a paper on this subject to B.A.A. Journ. for March. The only one that is large enough to measure with a micrometer is Titan, for which Barnard and Lowell agreed in finding a diameter of some 2600 miles, say 0·7″ in arc. Major Levin found 3500 miles by the eclipse of Rhea by Titan, April 8, 1921; probably the truth lies between the two. For the other satellites estimates can be made (1) from the masses determined by H. Struve, combined with assumed densities, and (2) from the stellar magnitudes of the satellites determined by Guthnick and at Harvard, combined with assumed albedoes. In practice each method was found to help the other; it was established that all the smaller satellites must have small densities, not much greater than that of Saturn itself, which is $\frac{1}{8}$ of the earth's density, or 0·7 of water. In particular, Mimas must have both low density and high albedo, and Major Hepburn suggested, half seriously, that it might be a gigantic snowball; he had in a former paper suggested that the Ring might be composed of ice crystals. The values of the diameters considered most probable are: Mimas, 300 miles; Enceladus, 450; Tethys, 700; Dione, 800; Rhea, 1000. Data are lacking for trustworthy estimates of Hyperion and Iapetus. As Jupiter's satellites have also low densities, some colour is given to the old suggestion that the outer parts of the solar system are built of less dense materials than the inner parts. It will be remembered that the inner satellites of Saturn are much the smallest bodies the masses of which have been determined gravitationally, hence determination of their densities throws new light on our knowledge of that of small bodies generally. Bodies that have never been in a molten state might well have interstices between their particles which would be filled up in a molten condition.

Annuaire de l'Observatoire Royal de Belgique, 1924.—Publication of this well-known Annual was suspended during the War, but the present volume is a very successful effort to make up for the lost years. It begins with the ordinary calendar, astronomical, and tidal information for the year, all given in great detail, and then follows a full summary of astronomical progress since 1915; thus Wolfer's monthly sunspot numbers are given for six years; they show a clearly defined maximum in the middle of 1917. The stages in the dissolution of the great eclipse prominence of May 1919 are fully illustrated. A full account is also given of work on the polarity of sunspots, the magnetic field of the sun, and Einstein's theory, and the discussions to which it has led. There are, in addition, tables and detailed accounts of planetary, cometary, and stellar work during the six years dealt with. The volume is thus very useful as an index and guide to contemporary astronomical progress.

Research Items.

DATING THE HEBREW EXODUS FROM EGYPT.—In the April issue of the *Fortnightly Review* Dr. H. R. Hall attempts to estimate the value of the recent startling discoveries in Egypt, but he defers a full appreciation until next winter's work and an examination, which must be protracted, of the objects in the tomb. More definite conclusions are reached by Mr. Arthur Weigall in the *Empire Review* for May. He identifies the 80,000 "unclean" people, whom Manetho says that one of the Pharaohs deported to the east bank of the Nile, with the heretic Aton-worshippers. Thus arises the question of the Hebrew exodus, which tradition has associated with Rameses the Great, the best known of the Pharaohs. But it more probably occurred in the reign of Tutankhamen, 1358–1350 B.C., and this is corroborated by the Karnak inscription, which states that he was employing Asiatic slaves in his great work of rebuilding the temples ruined by Akhnaton, a result which raises the question of the connexion of Hebrew monotheism with the earliest known monotheism of the Egyptians. It is also interesting to note that Tutankhamen in the same inscription speaks of Egypt as being plague-ridden in his reign.

FLINTS IN MALTA.—In the May issue of *Man* Miss M. A. Murray describes the results of excavations at a group of megalithic ruins of Borg en Nadur, overlooking the little harbour of Fort St. George, which forms part of the great bay of Marsa Scirocco on the south-east of Malta. During the excavation of this site last summer about thirty stone implements were found under the pavement west of the dolmen. They include three specimens the appearance of which suggests that they are part of an apparatus for producing fire. Throughout Malta flints of this kind, generally recognisable by the fact that they contain no cutting edges and have a characteristic semi-circular hollow on one side, where the stone had been struck by the steel, are often found. Until the last fifty years or so, flint was imported into Malta from Sicily for fire-producing purposes, and during the War, when there was a shortage of matches, these flints came into use again, and were sought for in the fields where they had been thrown away. The flints found at Borg en Nadur may have formed part of such a consignment.

CIVILISATION AND PRIMITIVE PEOPLES.—Mr. H. Balfour in his presidential address delivered before the Folklore Society, published in *Folk-Lore*, vol. xxxiv. No. 1, discusses the results of the expedition to the Naga Hills, Assam, whence he has returned with a rich store of material for the Pitt-Rivers Museum. In his address, he discusses the danger of interfering with the institutions and customs of primitive tribes. "To root up old-established indigenous trees and plant in their place alien substitutes to which the soil is unsuited is a useless and unproductive work; and equally futile and unprofitable is it to abolish ruthlessly old-established beliefs and practices, and to endeavour to replace them with imported doctrines and customs, which have developed under totally different conditions, and which merely puzzle the natives without enlightening them." In the districts most exposed to foreign influence—that of Christian missionaries and that of the Bengalis—he noticed "marked evidence of a comparative lack of that virility, alertness, and zest which I had observed in the more eastern districts, and the partial atrophy of these qualities is certainly correlated with the loosening of the grip upon traditional customs and ritual. I firmly believe that the comparative inertness is mainly the outcome of change of habit consequent upon contact with alien peoples and alien cultures." These conclusions, arrived at by a singularly competent and sympathetic observer, demand the attention of all British officers placed in control of primitive races.

RED SEA-WATER DUE TO A DINOFLAGELLATE.—Another instance of discoloration of the sea by a Dinoflagellate is recorded by K. Hirasaka (*Annot. Zool. Japon.*, x., Art. 15, Dec. 1922). In December 1921 discoloration of the water in Gokasho Bay, Japan, was observed and was found to increase until by January 10, 1922, the entire bay presented "a deep bloody or a chocolate colour," which continued to the end of February, when it began to diminish, and by the middle of March had disappeared. The depth to which the discoloration extended was from three or four to six feet. The organism, a new species of Dinoflagellate of the genus Gymnodinium, seemed to migrate diurnally according to the temperature and intensity of light, the colour of the water being deepest in the afternoon. The author states that the discoloured sea water was highly luminous.

JAPANESE MARINE TRICLADS.—T. Kabouraki (Journ. Coll. Sci. Imp. Univ. Tokyo, xliv., Art. 3, Sept. 1922) gives an account of the anatomy of the three marine triclads known from Japan, namely, *Procerodes lactea*, *Stummeria trigonocephala*, and *Ectoplana limuli*. The former two live beneath stones, but the last named occurs abundantly on the cephalothoracic appendages and on the gill-books of *Limulus longispina*, is 4 to 6 mm. long and about 1 mm. broad, and usually milky white. The author concludes a brief discussion of the integument with his opinion that the turbellarian epidermis is homologous with the cuticle of the trematodes, and he regards the rhabdites as the equivalent of gland secretions, and as being of use to the worm in securing food as well as in offence and defence. He states that all three worms are very sensitive and they usually move to a dark place, and that even on a slight shock they stop instantly, contract, and remain immovable. Ectoplana is not a parasite, and causes no injury to the Limulus on which it occurs; it lives on the fragments of food left over by the Limulus, and hence is a commensal. It lays its eggs on the gill lamellæ. Appended is a note on the classification of the marine triclads and a key to the genera.

SOME ANTARCTIC CRUSTACEA.—The latest in the series of reports on the British Antarctic (*Terra Nova*) Expedition (Zoology, vol. iii. No. 10), published by the British Museum (Natural History), is by Prof. W. M. Tattersall and deals with the Crustacea of the order Mysidacea. The usual but indefensible grouping of these with the very different Euphausiacea under the name "Schizopoda" is here abandoned. In addition to the purely antarctic collections, the report deals with a large amount of material obtained during the winter cruises of the *Terra Nova* off the north of New Zealand. A review is given of all the known antarctic Mysidacea, and it is pointed out that they were all taken in deep water and form part of the cold water fauna which is found in the depths of all the oceans. The littoral antarctic species, if any exist, are still unknown. So far as the evidence goes, however, the distribution of the group supports Regan's delimitation of the Antarctic Zone. From New Zealand only three adequately described species of Mysidacea have hitherto been known. In this report the number is increased to fifteen, of which eight are described for the first time. Seven of the new species belong to the genus Tenagomysis, to which only two species had previously been referred. This genus is only known from New Zealand and the

Auckland Islands. The *Terra Nova* also collected a few species in the Atlantic, of which one, obtained off Rio de Janeiro, is especially interesting. It is referred to Dana's long-forgotten genus Promysis, with which Hansen's Uromysis is identified. The other two species of the genus are from the East Indian Archipelago, but the seeming discontinuity in the distribution may be obliterated by further research.

Botany at the Carnegie Research Stations.—The Carnegie Institution maintains two special research laboratories, at Tucson, Arizona, and Carmel, California, where desert and coastal vegetation are readily studied, but in addition, as Year Book No. 21 of the Carnegie Institution of Washington shows, its workers are far more widely spread. In the Department of Botanical Research, under the general direction of Dr. W. T. MacDougal, fundamental researches by H. A. Spoehr and his collaborators are being carried out upon photosynthesis and respiration. Some of this work has been published in full since the issue of the Year Book, as Carnegie Publication No. 325 (Studies in Plant Respiration and Photosynthesis, Washington, February 1923). Space only permits the mention of the following points from the brief summary in the Year Book, which is packed with interesting facts and views: lævulose is not found to be so readily used in respiration as glucose: an explanation of the increased diastatic activity of leaves kept in darkness is found in the increased production of amino-acids and their effect on diastatic action: respiration and photosynthesis are found to be strikingly inter-dependent and affected alike by changes in various external factors. Chemists as well as botanists will be interested in the methods developed by Dr. F. A. Cajaro for the quantitative estimation of small amounts of the separate sugars in mixtures of glucose, lævulose, sucrose, and maltose; these methods depend upon oxidation under standardised conditions and upon estimation of cupric reducing power. Dr. W. T. MacDougal's work upon permeability leads him to consider lipins and pentosans as important constituents of the plasma membrane; the effect of different kations upon permeability is being considered from this point of view, with many new experiments in progress to elucidate the puzzling phenomena of "antagonism." Many ecological investigations by Forrest Shreve are in progress, and W. Cannon has been studying the evaporating power of the air and of the plant in South Africa. Dr. F. E. Clements directs another group of researches. One notes studies of the water cycle of the plant, of vascular conductivity by Prof. J. B. Farmer's method, and the effect of sap movement upon bud development; this work has supplied no evidence for the once very popular assumption of an inhibiting factor released by actively growing buds.

New Fossil Turtle from Arizona.—Attention was recently directed (Nature, March 31, pp. 443-4) to the remarkable assemblage of vertebrate remains collected by Dr. J. W. Gidley in the Pliocene of Arizona, and to the promise of further information concerning the reptiles. C. W. Gilmore now supplies the description and numerous figures of a new fossil turtle from that district (Proc. U.S. Nat. Mus., vol. lxii., art. 5). *Kinosternon arizonense*, n.sp., the first extinct representative of the genus in America, is most nearly allied to the recent *K. flavescens* (Agassiz), which, with one other of the eight living American examples, is said to range into Arizona.

Meteorological Stations in High Latitudes.—The U.S. *Monthly Weather Review* for January contains an article by Sir Frederick Stupart, director of the Meteorological Service of Canada, on the above subject, which formed a presidential address, given before the American Meteorological Society at Boston, Mass., on December 30, 1922. The author, while acknowledging the furthering of meteorology when aiding commerce and finance, suggests that difficulties arise in granting funds for the equipment of an out-of-the-way Arctic station, although the latter may materially improve weather forecasting. In the early days of forecasting in Canada and the United States the weather services were handicapped by the lack of data from the North. This great want has more recently led to the establishment of stations in Iceland and Spitsbergen, and still later in Jan Mayen Island. The Alaskan stations are said to have been of the greatest use for forecasters in the United States and Canada. Reference is made to the influence of radiation during the winter months over the land areas of Siberia and northern America, which leads to the formation of high pressure and intense cold, while in some winters the low pressure of the North Pacific tends greatly to modify the pressure distribution in northern America, and in these cases mild winters may be looked for. In some winters the Siberian high pressures extend across as one system into America, and great cold waves sweep southwards. The study of the dominant anticyclonic and cyclonic conditions seem so full of promise that the author emphasises augmenting the number of stations in the Arctic zone. The study of the conditions in high latitudes would help also to a better understanding of the severe storms along the Atlantic steamship routes.

History of an Oil-Well.—Probably few individual oil-wells are of sufficient technical, apart from commercial, importance to warrant their being the subjects of communications to learned societies. Yet the paper read by Mr. A. E. Chambers to the Institution of Petroleum Technologists on April 10, dealing with one of the earliest, largest, and most celebrated wells in Mexico, namely, Potrero No. 4, constituted not only an interesting but also a valuable dissertation on a matter of more than mere local importance. Mexico, in regard to oil-production, is a country of surprises; its wells, even if not always big producers, at least provide plenty of variety both in behaviour and in the problems they present during development and production. Not the least of these problems is that connected with salt-water, a particularly formidable one at the present time. The well under discussion was no exception. Situated in Vera Cruz State, 50 kilometres N.W. of Tuxpam, it was brought in as a gusher at the end of 1910 and not got under proper control till March 1911. Thenceforward it produced oil until 1914 when, after developing extensive seepage areas in its vicinity, it caught fire, owing to lightning, in August of that year. This fire was not finally extinguished until early in April of the following year, when the well started producing again and continued till the end of 1918. Emulsification set in in 1919, and this closed the history of the well. During this chequered career it produced no less than one hundred million barrels of oil, and the technical difficulties which had to be overcome in connexion with its control were of no mean magnitude, considering the fact that drilling methods in those days were somewhat crude compared with present-day practice. The oil originally produced was of an asphaltic base, s.g. 0·931 at 60° F. The pressure (closed well) amounted to 825 lbs. per square inch. Its ultimate appearance in the storage tanks was as an emulsion having a s.g. of 0·979 and containing 54 per cent. of salt water. In this departure it unfortunately foreshadowed the behaviour of many more recent wells in Mexico, a feature the significance of which has latterly been so widely debated.

The Rockefeller Foundation's Gift of the Institute of Anatomy to University College, London.

THE erection of the new building for the Department of Anatomy, which also provides an extension for the Department of Physiology of University College, London, completes the scheme for the development of the building for the Faculty of Medical Sciences which had long been contemplated. The proposal was first definitely formulated in 1907 on the initiative of Prof. E. H. Starling, who took an active part in collecting the money for the erection in 1908 of the Department of Physiology, which was opened in 1909 by the Right Hon. R. B. (now Viscount) Haldane. The generosity of the late Mr. Andrew Carnegie made it possible in 1912 to add to the eastern end of the Institute of Physiology a building to house the Department of Pharmacology, which was formally opened on December 4 of that year by Sir Thomas Barlow, president of the Royal College of Physicians. When the War seemed to have destroyed all hope of any immediate completion of the original scheme by the addition at the western end of a building to house the Department of Anatomy, the Rockefeller Foundation became aware of the difficulty and offered to provide the means for completing a scheme which harmonised with its ideals in medical education. It was eager to give some striking expression of American friendship to the British Empire, and was also anxious to enlist the help of the British medical schools in its great schemes for "the promotion of the well-being of mankind throughout the world."

The Rockefeller Foundation has long recognised how much the well-being of mankind is dependent on the advancement of medical knowledge and on the training of men who can spread the benefits of this knowledge among their fellow creatures, and to this end has spent large sums, not only in the United States, but also in South America and China, for the establishment of medical schools in which research and the education of medical men should go hand in hand.

At the end of 1919 two representatives of the Rockefeller Foundation, Dr. Wickliffe Rose, general director of the International Health Board, and Dr. Richard M. Pearce, adviser in medical education to the Foundation, came to Europe to inquire into the methods, problems, and needs of medical education in this country and on the Continent. While in London they were informed of the new developments in medical education which had taken place there under the stimulus and with the financial help of the Board of Education. This development consisted in the establishment at several of the medical schools of clinical "units" in medicine, surgery, and gynæcology, which were staffed by whole-time teachers, so that these subjects could be treated like the cognate scientific subjects, the professor being able to devote all his working hours to teaching and research without being obliged to undertake private practice. This innovation especially excited the interest of the representatives of the Rockefeller Foundation, since the Foundation had already played a large part in the encouragement and endowment of this system of medical education in America.

FIG. 1.—Institute of Anatomy, University College, London.

The essential feature of the system is the close co-operation between all departments concerned in the medical curriculum. It is recognised that medicine and surgery cannot advance except in association with other departments hitherto regarded as more purely scientific—in particular, pathology, anatomy, physiology, and bio-chemistry.

At University College, Drs. Rose and Pearce found a hospital which had been founded for the express purpose of medical education. They found also active and well-equipped institutes for the study of some branches of medical science and definite plans for the completion of the whole scheme of medical education as soon as the necessary funds were available. Thus in the College there was fair provision for physiology, pharmacology, and bio-chemistry, but no proper facilities for teaching and research in anatomy, embryology, and histology. In the clinical subjects of the curriculum, while medicine and surgery were represented by the whole-time professors at University College Hospital, there was a lack of beds devoted entirely to the work of these units, and the accommodation for research into the chemistry of disease was deficient; there was no provision at all for scientific investigation and teaching in midwifery and the diseases of women. Plans for remedying these gaps in the scheme were ready; the only thing necessary for the realisation of the scheme was money. The representatives of the Rockefeller Foundation were impressed with the possibilities of the scheme for the creation of a complete and scientifically equipped School of Medicine which had been worked out by the College and Hospital Medical School, and reported favourably thereon to the Rockefeller Foundation. As a result of their report the Foundation decided not only to place at the disposal of University College sufficient funds for the realisation of the scheme formulated in 1907, but also to provide the additional endowment required to maintain the increase in staff which the scheme entailed. At the same time the Rockefeller Foundation made an even larger gift to University College Hospital Medical School for the promotion of the work of the clinical units.

The new building provides adequate accommodation and equipment for the study of anatomy and the prosecution of research. It also gives tangible expression to a wider conception of the scope of anatomy, which will now include histology, embryology, experimental embryology and neurology, the study of animal movements by cinematography, radiology, and anthropology, and in fact the study of man in the widest interpretation of the term, his evolution, structure, and the history of his movements.

The completion of the building for the three closely allied sciences of anatomy, physiology, and pharmacology represents far more than the mere provision of accommodation and equipment for teaching and research in anatomy and of an extension of the physiological laboratories. It is the expression of a far-reaching scheme of cöoperation, involving on one hand the closer correlation of teaching and research in anatomy, physiology, and pharmacology, and on the other the linking up of the work done in the Faculty of Medical Sciences in the College with that done in the Medical School of University College Hospital. Moreover, the new building is a permanent symbol of the bond of sympathy that unites British medicine in a common aim with the medical schools of America and with the Rockefeller Foundation.

By housing the departments of anatomy (with histology, embryology, and anthropology), physiology, bio-chemistry, and pharmacology in one Institute with a library and staff-room in common, the way has been prepared for a closer co-operation between teaching and research in these subjects than has been possible hitherto. The new anatomy building is linked by means of a tunnel passing under Gower Street with the Medical School of University College Hospital, and it is anticipated that this physical avenue of communication will facilitate a freer intercourse between the workers upon the two sides of Gower Street, to their mutual benefit.

The extension of the department of physiology affords ampler provision for teaching and research in experimental physiology, and makes it possible for Prof. Starling to remain in the College as Foulerton research professor of the Royal Society, even though he relinquishes the Jodrell chair of physiology and the directorship of the Institute which he created.

Of the five floors in the building, the lowest is devoted mainly to practical work in anatomy, that is, dissecting and radiography; the next floor to teaching accommodation and museums, as well as to anthropological investigation; the third and fourth to research in anatomy, histology, and embryology; and the top floor to teaching in microscopic anatomy. A basement contains the heating chambers, coke cellars, tank, and specimen rooms.

The building, designed by Prof. F. M. Simpson, faces Gower Street, and has a frontage of 154 feet exclusive of the end gateway, which gives access to the south quadrangle. At the back it joins the physiology building. On a level with the students' entrance from the south quadrangle are the large top-lighted dissecting room, with prosectorium and annexe, the X-ray rooms, injection room, workshop, and cloakrooms for men and women students.

The rooms for the X-ray examination of the living subject and for the study of X-ray plates are near at hand, so that the students may be able, when dissecting any region of the body, to correlate the X-ray appearance with what they see and handle in their dissections. The X-ray equipment, the chief features of which are mentioned later in this account, has been superintended by Major Charles E. S. Phillips, who has spared no trouble in devising the best possible means for teaching anatomy by radiography.

The main entrance from Gower Street is at the ground-floor level, and leads by an oak-panelled vestibule to the hall and central staircase which serves all floors. On the ground-floor are the museum and preparation room, lecture theatre, fitted with the latest Zeiss epidiascope, demonstration theatre, and rooms set apart for teaching and research in anthropology.

On the first floor are the medical sciences library and periodical room, oak-panelled, with a book-store adjoining the room for the lecturer in the history of medicine, the private room and laboratory for the professor of anatomy, the dean's office, and a series of research rooms, including a laboratory for comparative neurology. In the latter will be housed a collection of neurological preparations, the nucleus of which consists of sections made by the late Dr. Page May and Sir Victor Horsley, and others presented by the Central Institute for Brain Research in Amsterdam at the instance of Dr. Ariens Kappers.

On the second floor are located the research laboratories for the professor of embryology, and a lecture room seated for about ninety students, with an apparatus for the projection of histological preparations. Also on this floor are situated a small chemical laboratory, a laboratory for research in experimental embryology, and the micro-photographic and dark rooms, while two rooms provide accommodation for collections of preserved material and microscopical preparations. Prof. J. P. Hill has made a very rich collection of mammalian embryos, and aims at making as complete a series as possible of human embryos. For research in comparative embryology the Institute offers unique opportunities.

The main students' laboratory for microscopical anatomy is situated on the third floor. It affords accommodation for about ninety students. Adjacent to the laboratory are the preparation room, the research laboratory for the assistant in histology, modelling and aquarium rooms. Accommodation for keeping live animals is also provided on the third floor, and provision has been made of facilities for experimental embryology and for the study of degeneration effects in the nervous system.

In a room set aside for the cinematographic study of animal movements, there is to be installed a cinematographic apparatus (so-called ultra-cinema) designed by M. Nogues, of the Marey Institute of Paris, by means of which it is possible to take up to 300 photographs per second of moving objects. This is perhaps the best method of analysis of reflex movements and muscular adjustments, such as those of posture. In presentation such movements can be made to occupy ten to fifteen times their normal time. Heavy electric leads are carried to this room so that brilliant illumination by arc or mercury lamps may be employed; while the flat roof is admirably adapted to the purpose of cinematography in summer.

The X-ray department is equipped with the latest type of apparatus for radiography in all its medical branches. Facilities are provided for rapid work as well as for the study of movement and anatomical structure as revealed by the latest X-ray technique of the day. The power unit consists of a 10 kw. transformer X-ray set, which supplies energy to the X-ray tubes either when working from below or above the operating tables, or when used for fluoroscopy; and arrangements are made whereby the portable trolley control may be connected either at a position near the tables or at a separate wall plug adjacent to the fluorescent screening-stand at the far end of the room.

One of the X-ray operating tables is fitted with automatically moving plate carriers beneath the top, which itself is hinged so as to render the tube box and diaphragm mechanisms readily accessible. The other operating table is fitted with a Potter-Bucky grid, and is the second table of the kind that has come to this country from the United States. As well as a large screening apparatus, there is a heavy type tube stand for general use, and a number of minor accessories. Apparatus for the special radiography of the head is also provided.

The high-tension overhead leads are made of nickel-plated tubing of sufficient diameter to reduce the formation of corona to a minimum, and a high-tension switch actuated by strings serves to connect the transformer terminals with the set of leads required for each apparatus as desired. The protection of all engaged in the work of the department has been carefully provided for, and stray radiation prevented from entering adjacent rooms by a covering of lead six feet high upon the walls. The lead sheet carefully lapped at the joints is hidden beneath stout boarding which serves to absorb the soft component of any secondary radiation which may be produced from the lead by stray radiation. The floor is covered with rubber. An adjoining dark room and large viewing room, together with a plate store, completes the department.

The installation has been carried out by Messrs. Watson and Sons (Electro-Medical), Ltd., London, who not only did the work of equipping the X-ray rooms, but also gave Major Phillips the benefit of their experience in designing X-ray apparatus.

The Rockefeller Gift has also rendered it possible to effect certain much-needed alterations and extensions in the departments of bio-chemistry, pharmacology, and physiology. On the ground floor the general bio-chemical laboratory receives an extension behind the anatomy theatre, providing additional places for advanced students in bio-chemistry. The bio-chemical research laboratories are also enlarged by taking in the whole ground floor of the pharmacology building, providing in this way two additional research laboratories and a private room for the professor of bio-chemistry. In pharmacology further accommodation for research is provided by dividing the present pharmacology lecture theatre into two laboratories. The pharmacology lectures will be delivered in future in the physiology theatre. This department receives also two extra laboratories on the second floor of the physiology building in compensation for the ground-floor laboratories surrendered to bio-chemistry.

A large part of the first, second, and third floors of the building connecting the present Institute of Physiology with the Institute of Anatomy is used for increasing the laboratory accommodation for research in physiology.

Concerning the architecture, the Gower Street front is entirely in Portland stone; the back portions in Arlesey brick with stone dressings to match the existing physiology and pharmacology buildings. The floor of the dissecting room, annexe, and prosectorium is of white mosaic, and the walls of white glazed brick. On the corridors is a strip three feet wide of quarter-inch cork carpet, with margins of white terrazzo in the basement, and of oak or pitch pine on other floors. A dado of terrazzo with green panels and white frames runs up the whole of the staircase and along the sides of the principal corridors. The floors of most of the working-rooms are cement, covered with linoleum. The steps and landing of the staircase are oak on concrete, with iron balustrade; and the museum, library, periodical room, and entrance vestibule from Gower Street have oak floors.

A passenger lift runs from the basement to the top of the building, serving all floors, and hand-power lifts are provided from the injection room down to the tank room, and from the tank room up to the annexe of the dissecting room. The whole of the building is steel frame construction.

It is of interest that the house in which Charles Darwin began the compilation of the notebooks for his "Origin of Species" is only four doors away from the new building, and it is hoped that eventually upon this site will be built a Darwin Institute of Anthropology and Biology which will worthily commemorate the greatest of English biologists.

Applications of Physics to the Ceramic Industries.

THE ceramic industries formed the subject of the fourth of the series of lectures on "Physics in Industry" which are being given under the auspices of the Institute of Physics, and the lecture was given by Dr. J. W. Mellor on May 9 at the Institution of Electrical Engineers. Sir J. J. Thomson, president of the Institute, was in the chair. Eliminating such applications of physics as are common to other industries, Dr. Mellor dwelt only on specific applications of sound, light, heat, electricity and magnetism, and mechanical science in the manufacture of pottery and glassware. He made it clear that, while in these industries much has been done to utilise physical principles and knowledge, there remains a very wide field in which present practice is crude and unscientific, and where all the help which the physicist can give is needed to replace obsolete, rule-of-thumb procedure by methods which are exact, efficient, and trustworthy.

Up-to-date manufacturers are following with keen interest the various attempts now being made to produce a mode of illumination to imitate natural light, for the matching of coloured glazes under artificial light is usually difficult and sometimes impossible. In one example quoted where the colour of a nickel-blue tile had to be imitated, it appeared that the copy was green in gas-light and blue in daylight. Many chrome colours which appear green in daylight are crimson, pink, or purple in gas or electric light. During the War, blue lamp bulbs were needed, but they had to appear blue when illuminated by the glow of a red filament. Had absorption spectra of colouring oxides been available, much money and labour spent in fruitless experiments would have been saved.

It was due to the measurements made by physicists on the indices of refraction of small crystals that the two crystalline forms of silica were detected, and the knowledge of the transformations has placed the whole manufacture of silica bricks on a sound scientific foundation. Recent work on X-ray spectra promises shortly to do for the fire-brick manufacturer what a knowledge of indices of refraction has done for the silica-brick manufacture.

Applications of magnetism have been but partially explored. One problem that has been almost solved is the separation of particles of metallic iron from clay slip. A system of electromagnets made by the Rapid Magnetting Company is ingeniously arranged so that if the magnets cease to work, the dirty slip will not pass into the purified slip. Success, however, has not yet been attained in removing particles of cupriferous pyrites from fire-clays.

The physicist-engineer specialising in heat problems has an illimitable field for his knowledge and skill. Dr. Mellor estimates that in firing biscuit-ware only 2 per cent. of the fuel is usefully employed, although the processes of brick-firing are much more efficient. Another series of problems awaiting solution is connected with the drying of clays and clay-ware, where serious losses occur owing to the development of drying cracks unless an inordinately long time is allowed. It appears that little progress is possible until the physicist has worked out the distribution of water in the interior of a drying mass of clay, and he will obviously have to take into account the relation between the surface of the drying solid and the humidity of the surrounding atmosphere.

Dr. Mellor referred to the studies of the thermal strains in "ideal" kilns upon which Prof. Lees is engaged; later it is hoped to apply these results to actual kilns, and he expressed the wish that Prof. Lees would pass on to consider contraction strains set up during the uneven drying and firing of special shapes. The results of such an investigation will not only explain why some shapes fracture and others do not, but they will also indicate to the designer of chemical and sanitary apparatus, furnaces and coke ovens, the shapes to be avoided on account of the narrow margin of safety in manufacture and use. Numerous interesting problems relating to the grain of clay await solution. It appears, for example, that the particles can be oriented differently so that the drying and firing contractions are different in different directions. Then there is the plasticity of clays to be studied, and, indeed, the whole problem of the hydrostatics and dynamics of liquids with an indefinitely large number of particles in suspension. Akin to this are the colloidal problems—now ever with us—but for some unaccountable reason, which he ascribed to chance, Dr. Mellor preferred to label this branch of his subject as chemistry and not physics.

Electricity is usefully employed in high temperature testing work, and also for crucible furnaces, but a satisfactory electric furnace for firing pottery has not yet been evolved, and in any case the cost of power is here a paramount consideration. Dr. Mellor indicated the novel problems connected with the effects of convection currents of hot air that would have to be solved if electrically-heated furnaces or kilns came into use. The conditions are quite different from those in gas- or coal-fired furnaces.

In conclusion Dr. Mellor referred to the physical problems connected with the glazing of pottery. The governing condition here is that the thermal expansion of glaze and body should be the same. Data so far obtained have not taken sufficiently into consideration the complex adjustment of glaze and body; for example, there is the tensile strength of the glaze to be considered, as well as the rate at which the glaze attacks the body and the effect of solution of the body in the glaze and its coefficient of expansion.

The lecturer's statement of the case for much closer co-operation between the ceramist and the physicist than has hitherto obtained was forcible and convincing.

The Meteorology of Scott's Last Journey.

THE Halley lecture for 1923 was delivered at Oxford on May 17 by Dr. G. C. Simpson, the director of the Meteorological Office, who took for the subject of his lecture "The Meteorology of Scott's Last March."

The polar party left Hut Point on November 3, 1911, and first traversed the Barrier, where it experienced a remarkable daily variation of temperature. In spite of the fact that the sun was continually above the horizon, varying only from 10° above the southern horizon at midnight to about 30° above the northern horizon at mid-day, the regular daily temperature variation on cloudless days reached the enormous value of 20° F. This necessitated travelling by night and resting by day. Several serious blizzards were encountered.

It is now clear that the Barrier blizzard is extremely local, being confined to the western half of the Barrier. During ten months with simultaneous observation at Framheim—Amundsen's winter quarters in the east—and at Cape Evans in the west, winds of more than thirty miles an hour occurred during 30 per cent. of the time at Cape Evans, and only 2 per cent. at Framheim. This is due to the fact that when the pressure is higher over the Barrier than over the Ross Sea the air tends to flow from the Barrier northwards to the sea, but is deflected to the west by the earth's rotation. The edge of the western plateau extends like a wall 8000 feet high for more than a thousand miles along the west of the Barrier and of the Ross Sea. This prevents the air moving freely to the west, with the consequence that the air-flow from the whole of the Barrier is concentrated in the west, and moves northward with high velocity, giving rise to the familiar blizzard.

When the polar party was at the foot of the Beardmore Glacier it experienced a serious blizzard which gave the greatest snowfall ever recorded in high southern latitudes. The cause of this bad weather was the formation of a deep depression over the Ross Sea, which produced a great flow of warm air from the Ross Sea to the south of the Barrier.

On reaching the plateau, low temperatures were experienced. During the five weeks that Scott and his party were on the plateau the mean temperature was −19° F., with a maximum of −3° F., and a minimum of −30° F. As they descended from the plateau, the temperature at first rose in the normal way, but while the party was still on the glacier a great change in the weather occurred. From this date—February 11—until March 20, extremely abnormal conditions were experienced. There was little or no wind, the temperature fell rapidly to the neighbourhood of −40° F., and ice crystals were deposited from the cold air upon the surface which acted like sand on the runners of the sledge. These thirty-nine days were the deciding factor in the fate of the party. "We all associate Scott's disaster with the terrible Barrier blizzards, and in the end a blizzard did prove fatal, but at this time a blizzard, a succession of blizzards would have been the salvation of them all."

The temperatures experienced by Scott on the south of the Barrier were between 10° and 20° F. below the normal for the time of year. In these conditions the returning party struggled on, becoming weaker and more dispirited every day. On March 16, Oates made his heroic sacrifice in order to give his companions a chance of safety. Then at last—on March 20—the blizzard did come. But it came too late, and continued too long. When it commenced the party had food and fuel enough to reach the depôt at One Ton Camp only eleven miles away, but as the blizzard continued to rage day after day the fuel was used and food consumed.

"There is little doubt that this blizzard removed the cold stagnant air and the conditions over the Barrier became much better for sledge travelling. But it was too late; by the time the blizzard ceased, every man of the polar party had passed away, and in doing so had left a record and created a tradition of which every Englishman is, and always will be, proud."

Movements of the Earth's Crust.

PROF. HANS STILLE of Göttingen has issued, under the title of "Die Schrumpfung der Erde" (Berlin: Borntraeger; price 1s. 8*d*.), a "Festrede" given to his university, in which he aptly reviews old and new theories as to the effect of the earth's contraction on the features of the surface. He holds that the conception of a general contraction towards the interior is well founded; but there are many ways in which it may become manifest by wrinklings of the outer crust. He finds that what G. K. Gilbert styled "epeirogenic" (now written "epirogenetic") movements, the sinking or uplifting of the crust over wide areas, are more in need of explanation than the folding of mountain-ranges, which has been differentiated as "orogenetic." The rhythmic pulsation, however, that causes mountain-building to occur simultaneously and even catastrophically over the whole earth presents an unsolved problem. Prof. J. Joly has suggested in a recent lecture (NATURE, May 5, p. 603) that the heat generated by radioactive minerals accumulates at intervals of some millions of years and so causes a catastrophe. Cooling of the uplifted layers by their being brought into proximity with the overlying oceans starts a new era of quiescence.

We may ask, with an equal sense of adventurous speculation, if the pulsation may not be still more primordial and connected with the beating of the last heart of an undivided universe. Prof. Stille keeps us from any such rash imagining; but he points out that the facts of orogenetic episodes are opposed to the uniformitarian doctrines of von Hoff and Lyell, which are applicable only to the intervals between great crustal foldings. Epirogenetic movements occur during these intervals, and characterise the epoch in which we live. On the whole, the earth loses heat by radiation faster than it acquires it by contraction; in this remark we recognise an adherence to views that some geologists regard as quite old-fashioned.

Prof. Stille's ten pages of "Anmerkungen" are almost as readable as the text of the pamphlet, since he adds to a wide range of references critical observations on many of the opinions cited. He remarks that Wegener's epochs of continental drift do not coincide with those in which orogenetic movements actually occurred. In these notes the author writes, as others have lately done, "Thetys" for Suess's well-chosen name "Tēthys," possibly by a confusion of Thetis, daughter of Nereus, with the wife of Okeanos, lord of the great outer seas. A. Sander's review of diastrophism and earth-history (*Geol. Rundschau*, vol. 13, p. 217, November 1922) should be read in connexion with Stille's memoir. Its author concludes similarly in favour of the contraction-theory, but regards epirogenetic movements as not necessarily very slow. Like Stille, he points out that we are moving a little way back to the views of the catastrophists.

The Steel Works of Hadfields, Ltd.

VISIT OF H.R.H. THE PRINCE OF WALES.

MUCH scientific interest is attached to the visit paid by H.R.H. The Prince of Wales to the works of Messrs. Hadfields at Sheffield, on May 29, when he started up the new 28-in. rolling mill, which has been installed at the firm's East Hecla works. This marks an important phase in the transition from war to peace production of this great establishment, the head of which is Sir Robert Hadfield, whose discovery of manganese steel in 1882 may justly be said to have originated the development of modern alloy steels. The new reversing 28-in. blooming and finishing mill is unique in several respects, having been designed to deal satisfactorily with steels of special nature, and in particular it is equipped with all the necessary improvements and labour-saving devices to obtain the most economical production. The mill motor has a maximum rating of 11,600 horse-power, and is supplied with current from a fly-wheel motor generator set, the cast-steel fly-wheel of which is 11 ft. 6 in. in diameter and 30 tons in weight. The mill motor is capable of being reversed from full speed in one direction to full speed in the other direction in three or four seconds. The rolls are 28 in. in diameter, and from 6 ft. 6 in. to 7 ft. long, being manufactured by Messrs. Hadfields of their special forged steel, and the mill is capable of rolling 15-in. square ingots, weighing 25 cwt., and reducing them to 2½-in. square billets at one heat. It will also be used for rolling special alloy steels, and rails up to their heaviest sections and 55 ft. long in manganese steel. The rolling plant accessories are all of the most modern type, including the necessary appliances for special treatment of manganese steel. The whole works show that British engineering is quite capable of designing, manufacturing, and running rolling mills and other steel plants second to none in the world. In addition to the 28-in. mill, the rolling plant also includes 11-in. and 14-in. mills for rolling round and square bars of alloy and other special steels.

An interesting feature of the Prince of Wales's visit was that he cast his own portrait on a plaque or medallion 22 in. in diameter of Hadfield manganese steel. The medallion was designed by Mr. S. Nicholson Babb, who has several sculptures in this year's exhibition of the Royal Academy. In the course of his tour the Prince was shown a number of exhibits illustrating the scientific work of the Hadfield Research Department. These included a complete equipment for all branches of the mechanical testing of iron and steel, and the latest apparatus in use for iron, steel, and fuel analysis, and oil testing. The scientific instruments used in the exact control of the heat treatment of special steels were also shown, and it is of interest to note that at one time no less than 15,000 pyrometer readings per week were taken in the works in the various steel making and treating departments. A demonstration was also given of the effect of low temperature on the properties of steel. Other interesting research exhibits included furnaces and methods of testing refractories; also apparatus for testing the electrical and magnetic properties of steel and its micrographic structure. A visit was paid to the firm's experimental proof butt in which are developed the large calibre projectiles for which Messrs. Hadfields are notable. Exhibits of historical interest included old metallurgical books from the valuable collection of Sir Robert Hadfield, and a number of ancient iron specimens from Egypt, India, etc. The Prince was also shown the original small transformer made in 1903 of the low hysteresis steel invented by Sir Robert Hadfield, which material, on the authority of Dr. T. D. Yensen, has since saved the world a sum equal to the cost of the Panama Canal.

Technology and Schools.

THE Association of Teachers in Technical Institutions held its annual conference on May 21 at Leicester. The new president, Mr. W. R. Bower, of Huddersfield Technical College, delivered an address on the position of technical education, in the course of which, after quoting with approval the views on this subject expressed in the Board of Education's Draft Regulations of 1917 for Continuation, Technical, and Art Courses, he described the aim of technical teachers as "to blend education with the life and work of the people." The special characteristic of their method is to bring education by means of part-time courses, not only to the homes of the people, but also into their workshops and offices. Comparing their work with university work, he said, "Our principal function is to develop character and mentality by means of higher education amongst the many: the university should be more concerned with the individual and his fitness to become a specialist of the first order; their successes so far have been in letters, mathematics, and science rather than in technology, even if physicians and lawyers are included amongst the technologists." The principal problem of technical education is "the satisfaction of the ambition of the young adult as a scholar, a craftsman, and a citizen."

Among other matters touched on in the address were: the increase since 1859 of the number of students in technical institutions from 500 to nearly a million; and science courses in secondary schools. "Dabbling in technology" is strongly condemned, as is the planning of school science courses for direct connexion with possible university courses or advanced professional study. On the other hand, close correlation with the work of the local technical college is commended. Mr. Bower also referred to the imminent prospect of publication by the Burnham Committee of a list of technical qualifications of teachers to be deemed equal to degrees—a prospect regarded with mingled feelings by the teachers, who foresee excessive stress being laid on paper qualifications. It was stated that the source of supply of prospective technological teachers is to be found only in industrial districts. The admission of advanced technical students to share in post-graduate and research work in universities, even when they do not hold the ordinarily pre-requisite degrees, was mentioned, and it was maintained that this concession would be of considerable benefit to the universities.

A resolution was passed by the Conference pressing for a committee of inquiry with the view of correlating technical education with education generally.

University and Educational Intelligence.

Aberdeen.—Prof. Matthew Hay has resigned the position of Medical Officer of Health to the City of Aberdeen, which he has held for thirty-five years.

Cambridge.—Mr. S. M. Wadham, Christ's College, has been reappointed as senior demonstrator in botany. It is proposed to confer an honorary M.A. degree on Mr. H. F. Bird.

London.—A course of four free public lectures on "Tropical Hygiene" will be delivered by Dr. A. Balfour, of the Wellcome Bureau of Scientific Research, at St. Bartholomew's Hospital Medical College on June 12, 14, 19, and 21, at 5 o'clock.

Notice is given that the election of a Sharpey physiological scholar will shortly take place. The scholarship, which is of the value of 200*l.*, is for one year, but renewable, tenable in the department of physiology at University College. Applications, with particulars of academic training and list of publications, if any, must be sent by, at latest, June 23, to the Secretary of University College, Gower Street, W.C.1.

Manchester.—The Court of the University has approved of the institution of a special diploma in bacteriology. This is the first diploma in this subject instituted in this country, and the courses of instruction which candidates will be required to attend before presenting themselves for examination are designed to supply a thorough training in the general principles of the subject, together with advanced courses in one or more special branches. Graduates in medicine and in science of any approved university may enter for the course, and the syllabus has been designed to meet the requirements of medical graduates who wish to qualify for bacteriological posts or to obtain a special knowledge of medical bacteriology, and of graduates in science who desire to take up some branch of bacteriological work. The diploma will be awarded to candidates who, after graduation in science or in medicine, have attended the prescribed courses over at least one academic year, satisfied the examiners in the written and practical examinations, and presented a satisfactory thesis on an approved subject. It is hoped that the action of the University in instituting this new diploma will meet the needs of a considerable number of post-graduate students for whom no adequate provision has hitherto been made, and will help to supply efficiently trained bacteriologists for the numerous posts for which they are now required.

A number of research studentships are being offered to university graduates by the Empire Cotton Growing Corporation, and will be awarded in July next. The studentships, which are each of the annual value of 250*l.* plus certain extra allowances, are intended to provide opportunities for additional training in scientific research bearing on plant genetics and physiology, entomology, physics, etc., or for the study of those branches of tropical agriculture which may be of service in agricultural administration or in inspection in cotton-growing countries. A studentship is offered by the British Cotton Industry Research Association to candidates having special knowledge of physics, engineering, or technical technology. Accepted students must be prepared to spend the period of their studentship at the West Indian Agricultural College, Trinidad, or in some other institution abroad selected by the Corporation. Particulars of the studentships and forms of application (which must be returned by, at latest, June 18) may be obtained from the Secretary, The Empire Cotton Growing Corporation, Millbank House, Millbank, S.W.1.

THE annual report of the University of London University College Committee (1922–23) records important developments in several directions. The new Rockefeller building for anatomy, histology, and embryology, and the engineering building, including the Charles Hawksley hydraulics laboratory, begun in 1919, are nearing completion and will be ready for occupation in October. A new department of chemical engineering will shortly be established. The student enrolment, abnormally swollen during the three years following the War, showed a decrease of 4 per cent. in 1921–22, but has since then remained steady: on January 31, 1923, it was 2513. The proportion of post-graduate and research students (16 per cent.) is very high. The undergraduates were distributed in 1921–22 as follows: arts 58 per cent., science 19, medicine 13, engineering 8, law 2. The number of students from abroad—518—is very large. Of this number 100 were vacation course students, of whom 33 were from France, 15 from Holland, 12 from Scandinavia, and 10 from Switzerland. There were 108 students from India, 27 from the United States, 23 from S. Africa, 26 from Japan; 30 per cent. of post-graduate and research students were from abroad, including 54 from India. The evening work of the College, mainly of a post-graduate character, is steadily increasing, so that the buildings are now open five evenings a week. Free public lectures by the provost, 15 professors, and 20 other members of the college staff, and by 29 visitors, were attended by more than 6000 persons, the approximate aggregate number of attendances being 13,500.

"ONE of the most important events in the history of higher education in Belgium," according to the president of the administrative council of the University of Brussels, was the decision of the government last June to grant a subsidy of one million francs to each of the two "free" or non-state universities—Brussels and Louvain. He cites the recent grants by the British Treasury to Oxford and Cambridge as precedents justifying the acceptance of such patronage, and asserts that, far from being menaced, the independence of his university is remarkably strengthened—apparently because the ministers understand that a subsidy implies no title to exercise control over university teaching. In each of these two universities five chairs have recently been endowed for 15 years by Mr. Hoover's C.R.B. (Commission for Relief in Belgium) Educational Foundation. Thanks to this endowment, to a grant of 20 million francs from the City of Brussels, and to gifts of several millions from the heirs of Ernest Solvay and their relatives, the École Polytechnique of the University of Brussels is now excellently equipped for training in civil and electrical engineering. A subvention of 30 million francs from the Rockefeller Foundation has enabled the medical school to modernise its seven-years' medical curriculum, more comprehensive courses in physics and chemistry being included in the earlier part, the final year being reserved exclusively for clinical work. Of the 24 Americans studying in Belgium under the "Fondation Universitaire" (C.R.B.) bursary scheme 20 were last year at the University of Brussels, where also were 71 other foreign students including only one from Great Britain.

Societies and Academies.

LONDON.

Linnean Society, May 10.—Dr. A. Smith Woodward, president, in the chair.—Paul **Kammerer**: Breeding experiments on the inheritance of acquired characters (see NATURE, May 12, p. 637).

Physical Society, May 11.—Dr. Alexander Russell in the chair.—J. H. **Jeans**: The present position of the radiation problem. (Guthrie lecture.) Classical dynamics are in conflict with experience with respect to the radiation problem. The discrepancies suggest that the laws of Nature must be discontinuous. To explain the observed nature of black-body radiation Planck propounded the quantum theory; in the hands of Bohr it soon became apparent that the quantum theory contained also the clue to the line spectrum. Einstein's hypothesis of light quanta appeared to possess obvious advantages, but has had to give way before the destructive criticism of Lorentz and others, and the direct experimental test of G. I. Taylor. The different methods of interchange of energy between matter and ether, or radiation, may be classified as sub-atomic, atomic, and mass transfers. Typical of the first is the emission or absorption of radiation by a Bohr atom; of the second, the motion constituting heat in a solid; and of the third, the transmission of momentum occurring when a beam of radiation falls upon the surface of a perfect reflector. Physical and chemical transfers take place by quanta, while mechanical transfers take place according to the classical laws. Applying the general principles to a special problem, the case of the exchange of energy between a free electron e and a field of radiation X, it seems probable that no exchange of energy can occur. A conception in regard to this which was used by Einstein in 1917 appears difficult to interpret except on the view that electric forces are a manifestation of a sub-universe more fine-grained than anything we have yet imagined.

The Faraday Society, May 14.—Sir R. Robertson in the chair.—E. P. **Perman** and H. L. **Saunders**: The vapour pressures of concentrated cane-sugar solutions. Few measurements have been made in the case of concentrated solutions except at low temperatures. In the present observations the concentrations were from 10 per cent. to saturation and the temperatures 70°–90° C. The vapour pressure was measured directly, the actual pressure being balanced against a column of mercury. The pressure-concentration graph is not a straight line, as in previous determinations by a dynamic method, and the results are in harmony with Callendar's theory that definite hydrates are formed in solution. The results also show that Babo's law holds for sugar solutions.—E. W. J. **Mardles**: The elasticity of organogels of cellulose acetate. The phenomena of the strain, variable with time and partly reversible, and the persistence of deformation and optical anisotropy, have been ascribed to the formation with time, while under stress, of a metastable phase, due to the altered orientation of the molecules composing the complexes which have aggregated to form the gel structure. The relation between the modulus of elasticity and concentration for the organogels of cellulose acetate is expressed (approximately) by the expression $E = kC^n$, at higher concentrations over limited ranges; n decreases with fall in temperature. The relation between log E and temperature is approximately rectilinear over the range of temperature examined. Addition of substances to the gel mainly affects the modulus in proportion to the change in the number of particles which aggregate.—A. L. **Norbury**: Some experiments in the hardness and spontaneous annealing of lead. When Brinell hardness tests are made in lead the "time factor" is an important variable. The load, therefore, has to be applied and removed almost instantaneously and loads up to 300 kg. only can be used with a 10 mm. ball. Loads were maintained for varying lengths of time and the results are interpreted according to Meyer's formula $L = ad^n$, where L is the load, d the diameter of the impression, and a and n constants. It appears that the more annealed the lead the more the results are affected by the time factor. With cold-hammering, lead is spontaneously annealed at room temperature, and the rate of annealing increases with the amount of deformation, so that lead which has been severely hammered shows no increase in hardness.—D. **Stockdale**: An example of polymorphism in an intermetallic compound. A study of the liquidus of the copper rich aluminium-copper alloys shows that the compound Cu_2Al exists, but is unstable above 1015° C. The compound can probably exist in two polymorphic forms.—F. C. **Thompson** and E. **Whitehead**: Some notes on the etching properties of the α- and β-forms of carbide of iron. The transformation of iron carbide at 200° C. has been studied from the point of view of the etching properties. The effects, positive or negative, of numerous reagents are recorded. The best reagent for differentiating between the two forms of carbide was found to be potassium copper cyanide. Incidentally the self-tempering of samples of white iron quenched from below 300° C. was confirmed.

CAMBRIDGE.

Philosophical Society, May 7.—Mr. C. T. Heycock, president, in the chair.—G. D. **Liveing**: The recuperation of energy in the universe.—J. E. **Purvis**: (1) Infra-red spectra. (2) The absorption spectra of some organic and inorganic salts of didymium. (3) The absorption spectra of solutions of benzene and some of its derivates at various temperatures. (4) The absorption of the ultra-violet rays by phosphorus and some of its compounds.—E. C. **Stoner**: A note on the electromagnetic mass of the electron.—R. R. S. **Cox**: Chemical constants of diatomic molecules.

May 21.—P. A. **MacMahon**: (1) The partitions of infinity. (2) The prime numbers of measurement.—M. H. A. **Newman**: On approximate continuity.—J. P. **Gabbatt**: The pedal locus in hyperspace.—D. R. **Hartree**: On some approximate numerical applications of Bohr's theory of spectra.—A. G. **Thacker**: Some statistical aspects of geographical distribution.—J. **Walton**: On the structure of a middle Cambrian Alga from British Columbia (*Marpolia spissa*, Walcott).—F. T. **Brooks** and W. C. **Moore**: On the invasion of woody tissues by wound parasites.

DUBLIN.

Royal Irish Academy, April 23.—Prof. Sydney Young, president, in the chair.—W. McF. **Orr**: Solutions of systems of ordinary linear differential equations by contour integrals. The writer starts with the equation $\phi(D)x=f(t)$, where ϕ is a polynomial of degree r. The solution, subject to the conditions that initially x and its derivatives up to $(r-1)^{th}$ shall have given values, may be written

$$2\pi i x=\int_c \frac{e^{\lambda t}}{\phi(\lambda)}\left[\frac{\phi(D)-\phi(\lambda)}{D-\lambda}\right]_{t=0} d\lambda+\int_c \frac{d\lambda}{\phi(\lambda)}\int_0^t e^{\lambda(t-t')}f(t')dt',$$

where the integrals with respect to λ are taken round a contour which encloses all zeros of $\phi(\lambda)$. Not only is this solution verified, but it is also obtained from the original equation. This is done by changing the independent variable to t', multiplying across by $e^{\lambda(t-t')}dt'$, integrating from 0 to t, multiplying across by $d\lambda/\phi(\lambda)$, and integrating round an infinite contour. Simultaneous equations are solved similarly.

PARIS.

Academy of Sciences, May 7.—M. Albin Haller in the chair.—The president announced the death of Sir James Dewar, corresponding member of the general physics section.—Henri **Lebesgue**: The singularities of harmonic functions.—M. **Mesnager**: Observations on a communication by M. Sudria (April 23).—L. **Joubin**: The cruises proposed by the Office scientifique et technique des pêches during 1923. A programme of the work proposed for the coming season on the *Pourquoi Pas?* under M. Charcot and on *La Tanche*, under M. Rallier du Baty.—M. **d'Ocagne**: Equations with four variables representable both by simple and double alignment.—C. **Depéret** and L. **Mayet**: The phyletic branches of the elephants.—M. Marin Molliard was elected a member of the section of botany, in succession to the late M. Gaston Bonnier.—Pierre **Humbert**: Certain orthogonal polynomials.—Paul **Lévy**: The stable laws in the calculus of probabilities.—Bertrand **Gambier**: Systems of superabundant points in the plane: application to the study of certain surfaces.—Jean **Dufay**: The spectrum of the nocturnal sky. In the part of the spectrum studied (plate excludes the green and yellow) the light of the sky at night has qualitatively the same composition as sunlight. E. **Fichot**: The peculiarities of the amphidromic regime of open seas.—S. **Rabinovitch**: The geometrisation of electromagnetic forces.—Pierre **Auger** and A. **Dauvillier**: The existence of new lines, one a Sommerfeld doublet, excluded by the principle of selection, in the L series of the heavy elements.—Victor **Henri**: The ultra-violet absorption spectrum of the vapour of benzene chloride. A reproduction of the spectrum is given, together with a diagram showing its decomposition into groups and series. From the spectrum the molecule would appear to be asymmetrical.—Mlle. I. **Curie** and G. **Fournier**: The γ radiation of radium-D and radium-E. The results are in good agreement with those found by Rutherford and Richardson. In addition the existence of a penetrating radiation due to radium-E has been established and its coefficient of absorption determined.—Suzanne **Veil**: The evolution of the molecule of chromium hydroxide in water.—H. **Pélabon**: The thermoelectric power of alloys. For alloys not forming definite compounds the thermoelectric power usually lies between the values corresponding to those of the pure metals, but the thermoelectric power can never be calculated by the mixture rule. Results for lead-antimony alloys are given.—M. **Aubert** and G. **Dixmier**: The stability of alcohol-petrol mixtures in the presence of water. The results are summarised in two diagrams showing the effects of the gradual addition of water to alcohol-petrol mixtures, with special reference to the point at which separation into two layers takes place.—M. **Sauvageot** and H. **Delmas**: The possibility of tempering extra mild steel at a very high temperature. As the amount of carbon in steel diminishes, approaching pure iron, the critical tempering temperature rises rapidly, and coincides with the melting-point when the carbon is a little less than 0·09 per cent. (with manganese 0·33 per cent.).—Paul Mondain **Monval**: Eutectic points in saline solutions.—Robert **Stumper**: The corrosion of iron in the presence of iron sulphide. Experiments showing that iron in contact with sulphide of iron is more rapidly corroded than when the sulphide is absent. The action is electrolytic, since the presence of the sulphide in the same water was without effect unless the iron and the sulphide were in direct contact or connected by an iron wire.—Pierre **Jolibois** and Pierre **Lefebvre**: The dehydration of gypsum. Gypsum heated in a current of dry air at varying temperatures gives no indication of the formation of the semihydrate. On the other hand, if heated in steam at 160° C., the semihydrate $CaSO_4 . \frac{1}{2}H_2O$ is formed.—Mme. Pauline **Ramart** and J. **Blondeau**: The molecular transformations accompanying the dehydration of the primary α-α-disubstituted phenylethyl alcohols.—MM. **Chaumeil** and V. **Thomas**: Researches on picryl sulphide. Study of the binary picryl trinitroanisol sulphide.—Raymond **Delaby**: The action of the magnesium halides on the epibromhydrin of ethylglycerol.—MM. **Bordas** and **Touplain**: Specific characters of the heavy oils of beechwood creosote. The presence of cerulignol in these tars, giving a blue coloration in alcoholic solution with lime or baryta, suggests that these heavy oils may form a suitable ingredient in the mixture used for denaturing alcohol.—Maurice **Piettre**: The estimation of humic and fatty materials in the soil by means of pyridine. Pyridine is an excellent solvent for humus. Diluted with an equal volume of water, it can be used to extract and determine the fixed and free humus in soil.—Ch. **Mauguin**: The reflection of Röntgen rays on certain remarkable reticular planes of calcite. The experiments described form a new confirmation of the hypothesis of W. L. and W. H. Bragg on the structure of calcite.—L. **Cayeux**: The phenomenon of imprints in the Mesozoic iron minerals of France. So far as the oolitic iron minerals are concerned, the impressions may have been caused by pressure alone, or by solution with or without pressure effects.—Léon **Bertrand**: The rôle of the Provençal advance folds in the tectonic of the Maritime Alps.—Pierre **Bonnet**: The existence of the Coniacian in the Daralageoz massif (Southern Transcaucasia).—Americo **Garibaldi**: Thyroidectomy and immunity. A comparison of the results by various workers on this subject leads the author to modify the view put forward by him in 1920. The removal of the thyroid causes an increased sensibility towards substances foreign to their internal medium, but at the same time the defensive power of the organism undergoes a marked increase.—M. **Tiffeneau** and H. **Dorlencourt**: A new series of hypnotics, the aryldialkylglycols. These glycols, of which phenyldiethylglycol, $C_6H_5 . CH(OH) . C(OH)(C_2H_5)_2$, may be taken as the type, show marked hypnotic properties both towards mammals and fishes. These properties are due to the glycol group, and are strengthened by trisubstitution: they vary, between certain limits, with the number of carbon atoms in the molecule, and are modified by the relative positions of the substituting groups.—Raphaël **Dubois**: Gyratory antikinesis.—P. **Vignon**: The mimetism of the Pterochroza.—Louis **Roule**: The peculiarities of the Rhône basin with respect to its ichthyological fauna.

WASHINGTON.

National Academy of Sciences (Proc. Vol. 9, No. 3, March).—H. S. **Reed**: A note on the statistics of cyclic growth. The lateral shoots on a young apricot branch develop typically in three groups along the branch, and their size and number are greatest in the group nearest the proximal end of the branch. The mean lengths of corresponding lateral shoots are symmetrical about a mean for each group.—R. A. **Millikan**: Stokes' law of fall completely corrected. The form of Stokes' law proposed is

$$F = \frac{6\pi\eta av}{1 + A' l/a},$$

where F is the force acting, v the velocity produced, η the viscosity of the medium, l/a is the mean free path over the radius, and A' is a factor which varies theoretically from 0·7004 to 1·164 as, with decreasing density, l/a changes from very small to very large values and allowance is made for a percentage of specular reflection at the surface of the oil. The change in A' means physically a change from viscous resistance to resistance due to molecular impact. Experimental values of A' obtained by the oil-drop method in several gases at varying pressures vary from 0·864 to 1·154.—C. **Barus**: Gaseous viscosity measured by the interferometer U-tube. For air, a capillary tube is attached to the closed limb of the U-tube containing air at slightly more than atmospheric pressure. The displacement of the interference fringes decreases exponentially with time, and the decrease is timed over equidistant scale parts of an ocular micrometer. The value found for air in a heated room is 0·000180.—T. W. **Richards**: Compressibility, internal pressure, and atomic magnitudes. Internal pressure is defined as the pressure exerted by the force of affinity. Curves were obtained, partly by extrapolation, for the pressure-volume relations of sodium, potassium, chlorine, and bromine, reduced to a gram-atom basis, and the atomic diameters of these elements in the chloride and bromide of each metal were computed. The compressibility of the products calculated from these data is said to agree with the experimental values. The results are in accord with the theory that atoms are subject to different pressures in different chemical combinations, and their bulks depend on this and on the compressibility of the elements concerned.—J. **Kendall** and E. D. **Crittenden**: The separation of isotopes. As applied to chlorine, a solution of sodium chloride in agar-agar jelly is made the middle section of a tube used as an electrolytic cell built in three sections each three feet long. Between the anode and the chloride is a sodium hydroxide gel and solution, and separating it from the cathode is a sodium acetate gel and solution, the latter containing acetic acid. The boundary surfaces remain distinct because the chloride ion is preceded by a faster hydroxyl ion and followed by a slower acetate ion. The sections of the cell are renewed as the boundary surfaces move, so that the chloride ion eventually travels through about 100 feet of gel; 110 or 220 volt lighting circuit is suitable. The isotopes, if of different ionic mobilities, will appear at opposite end of the sodium chloride gel column. It is also suggested that since the discharge potentials of the isotopic chloride ions in any naturally occurring solution differ by 0·03 volt, it should be possible to effect electrolytic fractionation.—J. W. **Churchman**: The mechanism of selective bacteriostasis. Acid fuchsin at 45° C. appears to kill Gram-negative organisms, while Gram-positive organisms are unaffected; gentian violet has the reverse effect. A mixture of two similar dyes showing this selective bacteriostasis may prove better for the treatment of infection than either alone.—H. C. **Sherman**: An investigation of the chemical nature of two typical enzymes: pancreatic and malt amylases. Malt amylase appears to consist of a coagulable protein and a proteose or peptone. Deterioration is due to hydrolysis. Pancreatic amylase is similar though less stable in solution. With both substances, hydrolysis was checked by the addition of amino acids. There appear to be two stages in the enzyme activity of pancreatic amylase, the latter of which is promoted when lysine and tryptophane are added, indicating that these acids are closely bound in the enzyme molecule as in typical proteins.—A. J. **Lotka**: Note on the relative abundance of the elements in the earth's crust. Arranging the elements appearing in the lithosphere, hydrosphere, and atmosphere in the order of the percentage in which they occur according to Prof. Harkins's data, some curious arithmetical properties of the percentages and atomic numbers appear. The results suggest that the earth's crust may be the product of subatomic disintegration of the nucleus on which it rests.—S. **Lefschetz**: Continuous transformations of manifolds.—J. W. **Alexander**: A lemma on systems of knotted curves. Every 3-dimensional closed orientable manifold may be generated by rotation about an axis of a Riemann surface with a fixed number of simple branch points, such that no branch point ever crosses the axis or merges into another.—W. M. **Smallwood**: The nerve net in the earthworm (preliminary report). Structures considered to be nerve fibres pass round the cells in the circular and the longitudinal muscles of the body wall and each blood-vessel appears to have a nerve net. The nerve net in the layer covering all the internal organs is very extensive, originating apparently in the body wall. The nephridia appear to have a particularly good nerve supply.

Official Publications Received.

Jahrbucher der Zentralanstalt fur Meteorologie und Geodynamik. Amtliche Veroffentlichung. Jahrgang 1918. Neue Folge, 55 Band. Pp. xiv+A24+B38+C30+F15. (Wien: Gerold und Komp.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Proces-Verbaux des Réunions. Vol. 29: Rapport Atlantique 1921. (Travaux du Comité du Plateau Continental Atlantique) (Atlantic Slope Committee). Par Dr. Ed. Le Danois. Pp. 75+19 planches. (Copenhague: A. F. Host et Fils.)

Department of Commerce: Circular of the Bureau of Standards. No. 138: A Decimal Classification of Radio Subjects—an Extension of the Dewey System. Pp. 33. 10 cents. No. 142: Tables of Thermodynamic Properties of Ammonia. Pp. 48. 15 cents. (Washington: Government Printing Office.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 216: Use of Geodetic Control for City Surveys. By Hugh C. Mitchell. (Special Publication No. 91.) Pp. v+80. (Washington: Government Printing Office.) 20 cents.

Smithsonian Institution: Bureau of American Ethnology. Bulletin 77: Villages of the Algonquian, Siouan, and Caddoan Tribes West of the Mississippi. By David I. Bushnell, Jr. Pp. x+211+55 plates. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 720: Economic Geology of the Summerfield and Woodsfield Quadrangles, Ohio, with Descriptions of Coal and other Mineral Resources except Oil and Gas. By D. Dale Condit. Pp. 156+12 plates. 30 cents. Bulletin 737: Manganese Deposits of East Tennessee. By G. W. Stose and F. C. Schrader. Pp. x+154+30 plates. 50 cents. (Washington: Government Printing Office.)

Department of Commerce: Technologic Papers of the Bureau of Standards. No. 235: Thermal Stresses in Steel Car Wheels. By George K. Burgess and G. Willard Quick. Pp. 367-403. (Washington: Government Printing Office.) 15 cents.

Diary of Societies.

SATURDAY, JUNE 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. A. W. Hill: The Vegetation of the Andes.

MONDAY, JUNE 4.

OIL CONFERENCE AT THE SIXTH INTERNATIONAL MINING EXHIBITION (at Royal Agricultural Hall, Islington), at 12 and 2.30.—E. H. Cunningham Craig: The Riddle of the Carpathians.—Dr. M. Kraus: Oil Deposits and the Tectonics of Vertical Pressure.—R. d'Andrimont: Note on the Genesis of Hydrocarbons and their Localisation in certain Zones of the Earth's Crust.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

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

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Sir Leslie Mackenzie: What does Dr. Whitehead mean by "Event"?

ROYAL SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. H. S. Hele-Shaw: The Stream-line Filter.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—F. Rodd: Journeys in Air.

TUESDAY, JUNE 5.

OIL CONFERENCE AT THE SIXTH INTERNATIONAL MINING EXHIBITION (at Royal Agricultural Hall, Islington), at 12.—A. Beeby Thompson: Oilfield Waste.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. M. Flinders Petrie: Discoveries in Egypt (3).

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Sir Edward Davson: The Economic Conference and Crown Colony Development.

FELLOWSHIP OF MEDICINE (at Royal Society of Medicine), at 5.30.—R. A. Hendry: The Value of Antenatal Supervision

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Prof. S. Russ: The Effects of X-rays of Different Wave-Lengths on Animal Tissue.—T. Thorne Baker: The Establishment of a Definite Relationship between Exposure and Density in an X-ray Plate.

WEDNESDAY, JUNE 6.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—R. H. A. Whitelocke: The Treatment of Fractures of the Patella.—W. White: The Closure of the Supra-pubic Fistula following Prostatectomy: Observations on Sixty-eight Cases.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. H. Bolton: A new Blattoid Wing from the Harrow Hill Mine, Drybrook, Forest of Dean.—Dr. C. E. Tilley: Contact-Metamorphism in the Comrie Area of the Perthshire Highlands.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—C. E. Horton: Wireless Direction-finding in Steel Ships.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, JUNE 7.

OIL CONFERENCE AT THE SIXTH INTERNATIONAL MINING EXHIBITION (at Royal Agricultural Hall, Islington), at 12 and 2.30.—Prof. J. Voitesti: The Mode of Appearance of the Petroleum Deposits in the Carpathian Region, with general consideration on the Genesis of the Petroleum and the Source of the Actual Deposits.—Major J. A. Lautier: An Economic Study of Petroleum Mining by Underground Drainage.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir William M. Bayliss: The Nature of Enzyme Action (2).

ROYAL SOCIETY, at 4.30.—Sir Charles Sherrington and E. G. T. Liddell: Stimulus Rhythm in Reflex Tetanic Contraction.—K. N. Moss: Some Effects of High Air Temperatures and Muscular Exertion upon Colliers.—F. A. E. Crew: The Significance of an Achondroplasia-like Condition met with in Cattle.

LINNEAN SOCIETY OF LONDON, at 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. J. B. Leathes: The Rôle of Fats in Vital Phenomena. (Croonian Lectures (1).)

CHEMICAL SOCIETY, at 8.—H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XX. The Rational Study of Optical Properties: Refraction a Constitutive Property.—A. E. Goddard: Researches on Indium. Part I. Diphenyl Indium Chloride and Phenyl Indium Oxide.—E. P. Perman and W. J. Howells: The Properties of Ammonium Nitrate. Part VI. The Reciprocal Salt Pair, Ammonium Nitrate and Potassium Sulphate.—E. W. Lanfear and J. F. Thorpe: Ring Chain Tautomerism. Part VI. The Mechanism of the Keto-cyclol Change in the Propane Series.—E. H. Usherwood: The Reversibility of Additive Reactions. Part I. The Aldol Reaction.—C. K. Ingold: Mechanism of the Pinacone-pinacoline and Wagner-Merrwein Transformations.—A. E. Goddard: Researches on Antimony. Part I. Tri-m-xylylstibine and its Derivatives.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—V. Bonney: Diurnal Incontinence of Urine in Women.—L. Phillips: The Treatment of Dysmenorrhœa, with Analysis of 100 Cases.

FRIDAY, JUNE 8.

OIL CONFERENCE AT THE SIXTH INTERNATIONAL MINING EXHIBITION (at Royal Agricultural Hall, Islington), at 12 and 2.30.—O. A. Young and S. D. Tuthill: The Standardisation Movement in America, and its Relation to and Application towards the Elimination of Waste in the Petroleum Industry.—G. Howell: The Caribbean Oil Region.

DIESEL ENGINE USERS' ASSOCIATION (at Institution of Electrical Engineers), at 2.30.—Eng.-Commdr. W. P. Sillince: Losses in Heat Engines and Means of Avoiding Them.

ROYAL ASTRONOMICAL SOCIETY, at 5.—W. S. Adams and G. Strömberg: Stellar Velocity and Absolute Magnitude: Note on a Paper by Prof. Eddington and Miss Douglas.—A. Buxton: Note on the Effect of Astigmatism on Star-Discs.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Prof. J. G. Gray: A General Solution of the Problem of Finding the True Vertical for All Types of Marine and Aerial Craft, to be followed by a discussion.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section) (Annual General Meeting), at 8.30.—Miss Ida C. Mann: Some Suggestions on the Embryology of Congenital Crescents.—P. Doyne: The Tournée Reaction.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Miss Joan Evans: Jewels of the Renaissance.

SATURDAY, JUNE 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. A. W. Hill: The New Zealand Flora.

PUBLIC LECTURES.

MONDAY, JUNE 4.

UNIVERSITY COLLEGE, at 5.30.—Prof. H. A. Lorentz: Problems in Relativity. (Succeeding Lectures on June 5 and 7.)

TUESDAY, JUNE 5.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Conflict within the Greek Moral Ideal. (Succeeding Lectures on June 12 and 19.)

WEDNESDAY, JUNE 6.

UNIVERSITY COLLEGE, at 5.—Prof. G. N. Lewis: The Structure and Behaviour of the Molecule. (Succeeding Lectures on June 8 and 12.)

THURSDAY, JUNE 7.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 4.30.—Prof. F. G. Hopkins: An Oxidising Agent in Living Tissues.

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SATURDAY, JUNE 9, 1923.

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NO. 2797, VOL. 111]

Medical Education in England.

IN a memorandum of nearly two hundred pages, addressed to the Minister of Health, Sir George Newman has reviewed some of the recent advances in medical education in England.[1] The occasion is timely. Never before has there been such an urgency and expectation of reforms; never, as since the War, such general appreciation of the vast potentialities of medical science in determining the society of the future. There is no medical school in Britain but has felt reinvigorated by the general sense of change and movement forwards. Like the celestial shades, Benevolence and Gratitude, in Tourguenieff's amusing satire, Science and Practice have been made acquainted. Of all the heavenly company they alone did not know each other before. Congratulation is free and happy; it is part of the new atmosphere of hope and fresh resolve.

Since the publication of an earlier memorandum in 1918 "there have been significant developments in Medical Education" in England, and medical education in England was, on the whole, ahead of the rest of the world already. Probably this last is a fair summary of the facts as they are presented here, not by Sir George Newman alone, but by a host of industrious correspondents, in great wealth of detail, albeit from diverging points of view. Darwin and Huxley among the naturalists, Shakespeare, Keats, and Wordsworth among the poets, are requisitioned to point the moral of Sir Clifford Allbutt, who has said that "at this moment it is revealed to us that Medicine has come to a new birth. . . . What is then this new birth, this revolution in Medicine? It is nothing less than its enlargement from an art of observation and empiricism to an applied science founded upon research; from a craft of tradition and sagacity to an applied science of analysis and law; from a descriptive code of surface phenomena to the discovery of deeper affinities; from a set of rules and axioms of quality to measurements of quantity."

The new knowledge came in almost bewildering succession—cell changes, toxins, immunology, asepsis, internal secretion, cardiology. "The medical man may now be, if he will, master of his fate"; and we know that this jubilation is scarcely in excess or ill-founded. We know that chemistry and physics have served the physiologist nobly and untiringly; that an enlightened anatomy, liberated from the narrow specialism of the dead-house, is rising to its old command of all biological problems; that British physiology

[1] "Recent Advances in Medical Education in England." A Memorandum addressed to the Minister of Health by Sir George Newman, Chief Medical Officer of the Ministry of Health and of the Board of Education. (London: H.M. Stationery Office, 1923. 1s. 3*d.* net.)

adds still to unequalled conquests; that "integration" in medicine has at least begun.

Why, then, should we turn from Sir George Newman's remarkable document dissatisfied and oppressed? It is not primarily the wealth of medical knowledge that is Sir George Newman's theme, but the problem of student inheritance. It may be true that "the most after all that can be accomplished . . . is to provide him with the tools of learning in order that by experience he may become a reliable and effective workman." It is true, if by "tools of learning" is meant something which, though vague, is positively and certainly immeasurably short of his ultimate attainment as a representative physician or surgeon, or an efficient general practitioner. In the most that can be accomplished is room for widely divergent ideals and attitudes. "Science," writes Dr. Bateson, "is not a material to be bought round the corner by the dram, but the one permanent and indispensable light in which every action and every policy must be judged. . . . The splendid purpose which Science serves is the inculcation of principle and balance, not facts."

Is this sentiment, so ingrained in the outlook of the man of science who necessarily looks forwards and away from the already known, a safe approach to the discussion of the adventitious and the merely academic in the medical curriculum? Over and over again it is borne in upon us that the medical student is the veriest beast of intellectual burden. The biologist writes threateningly that "if the medical man is not a biologist, he is nothing," while it is admitted that "what is necessary is a widening of the basis, less imposition of details on the memory of the student, and an introduction to scientific thought and method." In chemistry "the amount of detail imposed upon the student in didactic lectures is still perhaps too great." Anatomy "has been robbed of its heritage and reduced to the routine and detailed analysis of a scrapped machine, and the only goal has all too frequently been the examination test." The past student of anatomy was "overburdened with a multiplicity of detail, wearied with bone classes and a hundred systematic lectures, and harassed by meticulous examinations for which he is driven to prepare himself by 'cramming.'" Even in medicine and surgery "the student is overfed for his size." He attempts to learn, merely for examination purposes, much that is of little value, yet fails completely to master the simpler knowledge and manipulations which may fall to his lot frequently. How could it be otherwise when the prestige of famous schools depends upon pass lists and distinction lists, and not by any means upon the "inculcation of principle and balance" which only life, "never overlooking a mistake or making the smallest allowance for ignorance," can test? Much as the fame of some of them deserves to be founded in the breadth and distinction and power to influence of their teachers, that is the case in scarcely one. "At present, in spite of the reasonableness, high competency and goodwill of the examiners, the system remains a shackle upon medical education."

Sir George Newman offers two remedies for this malady. The first is time and the natural order of events, a necessary element, doubtless, in every advancement. The second is the acquisition of a more practical outlook throughout the training of the student. His science should be applied science. We wonder whether the historical and, as it were, developmental setting in which Sir George Newman has cast his study has not misled him there. Is the progress of medicine really an orderly progress as of one body? The point is sharpened by Prof. Halliburton, to whose views the memorandum gives assent. "I venture to think," he says, "that not infrequently the fault lies not with the physiological teacher, but with the hospital physician. . . . The physician, after an inadequate study of the science of physiology in the remote past, may have lost all touch and sympathy with the science of to-day, may have sunk into an easy empiricism, and may be content to cloak his ignorance by sneers at the application of scientific methods to practice." Thoughtful students have themselves recognised (or suspected) that it was there the bottom fell out of their curriculum. They had been taught to expect too much from practice: had confused applied science with the application of scientific methods. Sir George Newman regards the antithesis between the practical man and the inquiring man as false. But it is not false. It lies at the root of all the present difficulties of medical education. The "clinical unit" system—a genuine device of integration—may do much to resolve it; but confusion of thought in regard to it will prove the most dangerous obstacle to that great reform in medicine which now opens before us so hopefully.

British Coal-Mining in the War Period.

The British Coal-Mining Industry during the War. By Sir R. A. S. Redmayne. (Economic and Social History of the World War, British Series. Published on behalf of the Carnegie Endowment for International Peace.) Pp. xv + 348. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 10*s.* 6*d.* net.

SIR RICHARD REDMAYNE is to be congratulated upon having produced a work of quite exceptional interest; the history of the means by which the British coal supply, upon which our chances of victory so greatly depended during the War, was maintained, must necessarily be interesting, but it becomes even more so when it is told by one who himself played a leading part in this strenuous work. In no other way would it have been possible for the public to gain even an insight into the elaborate and complex operations that were required in order to maintain the output of this indispensable fuel through the whole of that trying and anxious time.

The inception of the present book is somewhat curious; it is published under the auspices of the Carnegie Endowment for International Peace, in pursuance apparently of a theory that the best way to prevent wars in the future is to explain all the details necessary to carry them on successfully. Whatever may be thought of this proposition, it has certainly given occasion for the publication of matter of the highest interest. Sir Richard's narrative is chronological, the leading events of each year, so far as the subject of coal supply is concerned, being grouped together. For much of what he has written he is and must remain the sole authority, but it can fairly be said that the description sounds very straightforward, and leaves on the reader's mind a convincing impression of impartial accuracy. Coal control necessarily bulks very largely, and it need scarcely be said that Sir Richard writes of coal control from the point of view of one of the controllers; it would no doubt have been an immense advantage to have had a companion chapter written by one of the controlled. The harrow appears to be remarkably well pleased with itself, but it is just possible that the toad may not be quite so appreciative.

Sir Richard is of the opinion that upon the whole the coal control worked well; and although it has been severely criticised in many quarters, the subject is so complex that it is difficult to see how any system could have been devised that would not be liable to many grave objections. Sir Richard, indeed, almost hints at defects when he points out, as he does in more than one passage, that direct financial control of the collieries might well have been avoided had it not been for the turbulence, selfishness, and disloyalty of one section of the industry—the coal miners of South Wales; he seems to think that their attitude rendered direct control absolutely necessary.

In appointing the coal controller it was possibly right to select a man of business ability and the power of organisation and administration rather than one possessed of technical knowledge and experience in coal production; but even though this may have been sound policy, it was certainly wrong to have chosen for his subordinates, for the men with whom the colliery manager would come into direct contact, so many who were unacquainted with mining matters. When a colliery manager found that the representative of the coal control, to whom he had to state his case and to whom the decision even in matters of great importance appeared often to be left, was absolutely ignorant of the elements of the mining industry, he naturally lost faith in the Department, and the coal control fell into disfavour, which could have been largely avoided had the subordinate executive of the coal control known more about coal mining. It may possibly not be true that the colliery manager who asked for a new winding rope 300 fathoms long was informed that the Department could not grant him more than 150 fathoms, or that a request addressed to the coal control for washed nuts was referred to the food controller; but the mere fact that such stories were current shows well enough how little confidence the coal control department succeeded in inspiring into the coal trade.

Necessarily, the doings of the coal control and the various sub-departments into which it was divided make up the greater part of the book, but probably to many readers the final chapter, in which Sir Richard summarises the economic history of the coal industry and gives the conclusions which he himself draws from this review, will be the most interesting. At the present moment it is perhaps most important to point out that Sir Richard's views have matured since he gave his evidence before the Sankey Commission; he there carefully avoided expressing any decided views on the nationalisation of collieries, and went so far as to say that in his opinion no man can say whether mines would be as efficiently run if they are centralised and run as a national concern as they are under present conditions. Now he writes very differently: "Complete freedom of action for those engaged in the management is absolutely essential to the successful conduct of so highly organised and technical an industry as that of coal-mining. Where an industry has to be conducted under a great diversity of conditions the edicts of a central authority stand in constant need of modification as they are applied to particular cases. Otherwise work will be conducted wrong-headedly and in defiance of material facts. True as this is of all great industrial concerns, it is particularly so in the case of mining." "Whatever results may accrue from such a policy [*i.e.* nationalisation], from the record of observation I find great difficulty in believing that it would make for efficiency. . . . Even if nationalised control were not vetoed by the inherent physical difficulties of the case, it would still have the disadvantage of removing from the industry the great energising forces of personal responsibility and initiative."

If this book did nothing else than record in such unmistakable language Sir Richard's adhesion to the views that have been expressed by practically every one experienced in the technical administration of collieries, it would serve a most useful purpose at the present moment; but in addition it presents, as has been indicated, an inside view of one of the most complex of the various emergency administrations developed by the stress of war conditions, and forms a document which no student of industrial economics can afford to neglect. H. Louis.

The Structural Units of the Body.

Emil Fischer—Gesammelte Werke. Herausgegeben von M. Bergmann. *Untersuchungen über Aminosäuren, Polypeptide und Proteine II.* (1907–1919). Von Emil Fischer. Herausgegeben von M. Bergmann. Pp. ix + 922. (Berlin: Julius Springer, 1923.) 24*s.* 2*d.*

At the beginning of the twentieth century knowledge of the nitrogenous constituents of the body lagged far behind that of the fats and sugars, and the information available as to the composition and structure of the various forms of protein was of the scantiest. Within five years a complete change in this respect was effected as the result of the labours of Emil Fischer and his pupils—not only were the constituents of the proteins almost completely identified both qualitatively and quantitatively, but also the artificial synthesis of most of the individual units was effected, and the first steps taken towards their coupling together to form polypeptides.

Fischer's pioneer work on the amino acids, polypeptides, and proteins commenced just prior to his taking possession of the new laboratories in the Hessischestrasse, Berlin, about 1899, and during the next six years this was his main work: he republished his collected papers in 1906. Dr. Bergmann has now collected the further publications in this series up to 1916: they amount to a stately volume of 892 pages. During the last few years of his life Fischer worked in the main at problems in sugar chemistry, but he always spoke of his intention to return to investigations of the proteins.

The papers reprinted in the volume before us fall naturally into four classes—the investigation of the individual amino acids which form the units from which the proteins are built up, the synthesis of polypeptides of ever-increasing structural complexity from the amino acids, the investigation of the degradation products of protein hydrolysis, and the study of the remarkable so-called Walden rearrangement of groups attached to asymmetric carbon atoms, which takes place during a variety of relatively simple chemical reactions. The value of the collected papers as a work of reference is materially enhanced by a carefully prepared index.

Fischer's work in these fields is in many ways typical not only of the man himself but also of the German method. The problem was attacked thoroughly, methodically, and systematically, with all the resources of a great and newly-equipped laboratory; an adequate number of trained assistants were available, funds were not lacking, and the time of the professor himself was not too much occupied by routine and administrative work, which could be performed equally well by a less gifted individual. Publication was prompt, and could be secured without that friction with editorial committees which is so destructive of enthusiasm.

In all, nineteen amino acids have been separated as products of protein hydrolysis. Glycocoll was isolated so far back as 1820 by Braconnot, who obtained it from gelatin, together with leucine, which Proust had found two years earlier in cheese. Oldest of all is cystine, the only protein constituent containing sulphur in its molecule, which was discovered in 1810 by Wollaston. Fischer added proline and oxyproline to the list in 1901–2, and discovered the more complex diaminotrioxydodecanic acid in 1904. Hopkins and Cole isolated tryptophane in 1901. The amino acids typify all classes of acids: normal paraffins, aromatic analogues and their hydroxy derivatives, dicarboxylic acids, heterocyclic pyrrolidine compounds, imidazols, indols, and lastly diamino substances. They occur in the proteins as optically active forms, and have mostly been synthesised in this form.

Having fully characterised the amino acids, Fischer's next step was to devise methods of coupling them together, at first in pairs, to form what he named dipeptides, and afterwards in increasing numbers until a molecule approximating in complexity to the actual protein was obtained. It will be evident that the number of possible isomerides of such compounds obtained by altering the order in which the various amino acids are linked together is very large. Thus for an octadecapeptide synthesised by Fischer from 15 molecules of glycine and 3 molecules of lysine there are 816 possible different methods of arrangement. Judging from the results of the analysis of the products of the partial hydrolysis of the natural proteins, they never contain long chains of a single amino acid, but are highly complex, each following link in the chain being a different acid. In this respect there is a resemblance to the fats, the natural compounds being in the main mixed glycerides containing several fatty acid radicles. As a consequence the number of possible isomerides of a product having the structure of casein is enormous. When our methods are more refined, such minor variations may possibly serve to explain the differences between the caseins derived from the milk of various animals and the highly specific behaviour of various proteins in immunity tests. Of outstanding importance is the fact that the synthetic products are attacked by those enzymes which normally effect protein digestion. Material is thus afforded for the systematic study of the fermentative processes in the organism, and it may be claimed that the chemist has gone a long way to meet the physiologist on common ground.

The synthesis of the type protein may be said to have been accomplished by Fischer, but the synthesis of an actual protein is quite another matter, and least of all will it ever be possible economically to make synthetic protein at a price to compare with the product of the vegetable world. Alike with sugar, fat, and protein, it is the problem of man so to increase yield, and maybe quality as well as quantity, as to provide a sufficiency of cheap food for our needs. The application of chemical knowledge to agriculture and to horticulture in ever-increasing intensity is not the least important of our tasks.

At the moment of putting down this monumental work, with more than a pang of sorrow that its author has passed beyond, one cannot help the involuntary comparison with an entirely different type of chemist of our own race—Sir James Dewar. Fischer, the patient, untiring observer and investigator in the organic laboratory, never allowing himself to deviate from his plan. Dewar, all genius and impatience, full of daring, an artist above all both in his science and his spirit. E. F. ARMSTRONG.

Actuarial Mathematics.

(1) *Calculus and Probability for Actuarial Students.* By A. Henry. (Published by the Authority of and on Behalf of the Institute of Actuaries.) Pp. vii + 152. (London: C. and E. Layton, 1922.) 12s. 6d.

(2) *Life Contingencies.* By E. F. Spurgeon. (Published by the Authority and on Behalf of the Institute of Actuaries.) Pp. xxvii + 477. (London: C. and E. Layton, 1922.) 30s.

(1) MR. HENRY'S volume contains a course of differential and integral calculus, coupled with finite differences, designed primarily to meet the requirements of actuarial students. Stress is laid throughout on the numerical methods with which actuaries are mainly concerned. The treatment of the differential and integral calculus suffers from lack of rigour and would not satisfy a modern pure mathematician. It contains nothing, however, likely to mislead those whose main interest lies in the numerical applications.

The eight chapters on finite differences give all the most useful rules for interpolation, both direct and inverse. A numerical example, to evaluate $f(2{\cdot}33333)$, given $f(2{\cdot}30103)=200$, $f(2{\cdot}32222)=210$, $f(2{\cdot}34242)=220$, $f(2{\cdot}36173)=230$, is worked out by four methods which lead to the same result, 215·442. Such illustrations as this tend to increase the faith of a reader sceptical about the validity of the formulæ. The section on integral calculus contains a useful chapter on approximate numerical integration including the formulæ of Lubbock, Woolhouse, Simpson, Weddle, and G. F. Hardy. A chapter on probability and a collection of examples conclude the volume. Mr. Henry's book is one which can be strongly recommended, not only to actuarial students, but to all whose work lies in the numerical applications of the calculus and finite differences.

(2) The second volume before us is issued as the "official" text-book on life contingencies. It discusses mathematically such subjects as mortality tables and their statistical application, probabilities of life and death, and all the usual types of assurance and annuity. A mortality table, on which the calculation of assurance data rests, is necessarily constructed from experimental evidence: it gives the number of people, among N aged n years, who may be expected to attain the age of $n+x$ years. The usual tables are: (1) English life tables compiled from census returns and death registers, (2) tables compiled from the experience of British life offices, relating to the *select* class of lives with which the companies have dealt, and (3) such tables as Gompertz's and Makeham's, which are based on conjectured theoretical expressions for the functions occurring in a life-table.

Mr. Spurgeon's volume will now be accepted as the standard treatise, so far as the subjects with which it deals are concerned. A reader possessing a fair working knowledge of elementary mathematics, including the calculus and finite differences so far as they are contained in Mr. Henry's companion volume, should be sufficiently prepared to read most of it. The arguments throughout the book are clearly presented, and the theory is illustrated by many solved numerical examples—most of which involve using data supplied by the tables.

We cannot help thinking that the notation adopted for some of the actuarial functions is unfortunate. In certain types of mathematical work a multiple-suffix notation is helpful, but such symbols as

$$ {}_{t}V^{(m)}_{[x]\,\overline{n}|}, \qquad {}_{n|}A^{1}_{[x]\,\overline{m}|}, \qquad {}_{t+\frac{r}{m}}V^{(m)}_{[x]} $$

present considerable difficulties to both printer and

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reader. It would certainly be desirable for such an intricate notation to be simplified.

The book ends with eighty pages of tables giving the numerical values of certain actuarial functions according to various laws of mortality.

W. E. H. B.

Our Bookshelf.

Nutrition de la plante: utilisation des substances ternaires. Par Prof. M. Molliard. (*Encyclopédie Scientifique: Bibliothèque de Physiologie et de Pathologie végétales.*) Pp. 306. (Paris: Gaston Doin, 1923.) 15.40 francs.

In this volume the author has aimed at presenting, as a concrete whole, much of the scattered information with regard to the ultimate utilisation of the non-nitrogenous compounds produced by plants in the course of their metabolism. Dealing in the first place with the digestion and migration of reserve materials, chiefly sugars, starches, and oils, attention is directed to the function of the various diastases, and to the mechanism of diastatic action. It is concluded that diastatic reactions represent merely a particular case of the ordinary catalytic phenomena, the apparent discrepancies being explained by the colloidal nature of the catalyser and the physical properties of the products resulting from the reaction. Respiration, with its attendant phenomena of oxidation, is discussed in some detail with special reference to the function and mode of action of the oxydases. Other oxidation processes are exemplified by fermentations induced by some of the lower fungi and bacteria, as in the production of acetic acid by various bacteria and oxalic and citric acids by certain Mucedineæ. The final chapters deal with fermentations which do not result in the fixation of oxygen, particularly alcoholic fermentation and intramolecular respiration, together with the production of such substances as lactic and butyric acid by bacteria in the presence of the appropriate sugars. The book thus provides a useful résumé of the aspect of plant nutrition with which it deals.

Matter, Life, Mind, and God: Five Lectures on Contemporary Tendencies of Thought. By Prof. R. F. Alfred Hoernlé. Pp. xiii + 215. (London: Methuen and Co., Ltd., 1923.) 6*s*. net.

The five lectures in "Matter, Life, Mind, and God" present us with the main tendencies of philosophical thought in respect of the great problems of philosophy indicated by the title. Prof. Hoernlé's aim is to consider these questions synoptically, and he shows admirably how no one abstract point of view of a single science can be considered as having exhausted reality. His treatment of the relations of science, religion, and philosophy, of the tendency away from a materialistic outlook (he calls this chapter "The Revolt against 'Matter'"), of the order of Nature, of the nature and function of mind, and of religion and the meaning of "God," is fresh and stimulating. The book suffers from a certain diffuseness, which is perhaps inevitable considering the wide range of the tendencies of thought which are considered in it; and this fact is apt to mask the synoptic conclusions which the reader is expected to draw from it. There are excellent bibliographies appended to each chapter, with notes as to the relevancy of works cited to various positions stated in the text.

Memories of Travel. By Viscount Bryce. Pp. xiii + 300. (London: Macmillan and Co., Ltd., 1923.) 12*s*. 6*d*. net.

From many notes of travel, written in various parts of the world, these sketches have been selected for publication. They cover a wide range, Iceland, Poland, the Alps, Palestine, Siberia, North America, and the islands of the Pacific. Slight as most of the chapters are, they were well worth publication. Lord Bryce was a careful observer of Nature and had interests so wide and a taste in scenery so catholic that every land seems vivid before the reader's eye. His charm of style and ease of description make one overlook the occasional weakness in his geological explanations. The chapter on Iceland, written in 1872, gives a description of Icelandic scenery and peasant life that could scarcely be improved and yet it runs to less than fifty pages. Vivid pictures of Tahiti, of travel in the Altai mountains, or climbing in Europe are equally fresh and interesting. Even his "catalogue of the scenery of North America" is most attractive, although the whole continent is embraced in some two dozen pages. It is to be hoped that further sketches will be selected for publication from the wealth of material which Lord Bryce left. There is ample room among works of travel for these delightful sketches.

The Appearance of Mind. By James Clark M'Kerrow. Pp. xv + 120. (London: Longmans, Green and Co., 1923.) 6*s*. net.

This is a first book by a young author. It is a striking argument ably developed. It is almost a commonplace in philosophy to deny the reality, in the sense of substantial or causal unity, of the object of knowledge, and to reduce things to phenomena. Mr. M'Kerrow holds that the notion of mind is even more misleading and less justifiable. It must be desubjectified in a way which even Hume did not succeed in attaining. The immaterial principle which he would substitute for mind is "viable equilibrium." He denies that his theory is identical with behaviourism, which is equally anxious to disclaim mind, but he suggests that it may supply just what is wanting to behaviourism to make it work.

The Chemistry Tangle Unravelled: being Chemistry systematised on a New Plan based on the Works of Abegg, Kossel, and Langmuir. By Dr. Francis W. Gray. Pp. x + 148. (London: Longmans, Green and Co., 1923.) 6*s*. net.

This book is mainly an exposition of the work of Kossel. In spite of its title, it does not throw any new light on chemical problems, and the student would be well advised to read the original papers of Kossel, Lewis, and Langmuir rather than to attempt to absorb their theories in the less attractive form in which they are presented by Dr. Gray.

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.*]

The Isotopes of Germanium.

Using the improved method of accelerated anode rays I have been successful in obtaining the mass-spectrum of germanium. The anode contained a fluorine compound made by the action of HF on a pure specimen of germanium oxide for which I am indebted to Prof. Dennis of Cornell University.

The effects are somewhat feeble, but satisfactory evidence of three isotopes has been obtained. Their mass-lines are at 70, 72, 74, and appear to be whole numbers though the accuracy of measurement is not so high as usual. The intensities are roughly in the proportion 2 : 4 : 5, which agrees reasonably well with the value 72·5 for the chemical atomic weight at present in use.

These values conform to the general rule connecting even atomic number with even atomic weight. It will be noticed that Ge^{70} is isobaric with the weakest and heaviest component of zinc discovered by Dempster, and Ge^{74} isobaric with the lightest and weakest isotopes of selenium announced in NATURE of November 18, 1922, p. 664.

F. W. Aston.

Cavendish Laboratory,
Cambridge, May 23.

The Wave Theory and the Quantum Theory.

In a letter published in NATURE on December 23, 1922, I put forward a theory of dispersion which attempted to begin the reconciliation of the quantum theory with the wave theory. I have received several letters criticising my hypothesis, and it seemed to me that it would be well to acknowledge the justice of the criticism. By a small change it is possible to meet the objection, but this change carries certain important implications. In my former letter, in order to be concise, I had to get as quickly as possible to the positive results, but here I wish to set out the train of thought from which the hypothesis started, and to indicate some of its consequences. It is perhaps well at once to say that in its present shape the hypothesis is in rather severe difficulties over one phenomenon, but nevertheless the argument leads to a good many criticisms of existing theories which may be of interest.

It must be taken as absolutely certain that both the electromagnetic theory and the quantum theory are valid in their respective fields, and equally certain that the two descriptions are incompatible. We can only conclude that they are parts of an overriding system, which would give rise to mathematical formulæ identical with those of the present theories. It is true that from the present theories predictions can be made which are verified; this does not confirm the physical pictures associated with those theories, but only shows that the limits of their validity have not been reached. Now although the developments of the quantum theory in the past ten years have been enormous, and though there is no sign of their ceasing, yet these developments have not tended in the very smallest degree towards closing the gap which separates it from the wave theory. For this reason it seemed to me that the only hope of finding a reconciliation must lie in some other direction, and that it would be best deliberately to give up thinking of details and to go back to fundamentals.

In starting to modify existing theories it is obviously best to change as little as possible, and therefore we have at once to choose whether it shall be the wave theory or the quantum theory which shall serve as basis. On this question there will be a great diversity of opinion, but to me it seems that the wave theory is undoubtedly to be preferred. The chief reason for this is that, so far as we know, the classical theory gives correctly the observed results in the interference of light, no matter how high the frequency or how feeble the intensity; so that even if we could find a new language in which to describe interference, it would be possible exactly to transform the mathematics which expressed it into the present language of waves. In other words, the wave equations imply an infinite number of degrees of freedom and it can make no difference by what name these degrees are called. The main objection to the electromagnetic theory is that it claims to present a *complete* system of mechanics, and it is this completeness that is its fault; but the wave theory is only a part of the electromagnetic theory, and we can get a large latitude for modification by retaining only this part and altering the part which describes the interaction of waves with matter.

In the quantum theory it must be conceded that, for such things as resonance potentials or the hydrogen spectrum, it is extraordinarily difficult to conceive of any alternative explanation; but, even allowing for the danger of being over-critical of an avowedly incomplete theory, it is not too much to say that from first to last the associated physical picture is in great difficulties. In the first place frequency, which plays such a leading part in the theory, is not at all the same thing as it is in mechanics, and is not susceptible of any clear definition. Then there is the difficulty that the quantum conditions determining the permissible Bohr orbits can only be explained physically by attributing to the electrons a knowledge of the future. Again there is the extreme formalism of the Correspondence Principle, a most powerful method of advance, but one which even by itself would force one to believe in the inadequacy of the quantum picture. A great part of the success of the theory of spectra has lain in the demonstration that the properties of the atom can be described in terms of whole numbers, but the dynamical concepts associated with these numbers are chiefly derived from analogy with the case of hydrogen, and could be reinterpreted in conformity with any new interpretation that was found for hydrogen. For all these reasons it is natural to suppose that the complete picture will resemble the classical theory much more closely than it will the quantum theory.

In my former letter I brought up the point that there is no reason to believe in an exact conservation of energy, but only in a statistical balance. The point is not at all new, but from much discussion of the subject I think there is no doubt that many physicists consider a breach of the law of conservation as a serious objection to any theory. If we are to believe at all in the wave theory it is much more reasonable to maintain the exact opposite. The photoelectric effect is an impossibility in conjunction with the wave theory if energy is exactly conserved, but if only a statistical balance is required, then it becomes nothing more than one unexplained problem among others. Again there exist rigorous proofs that no system of differential equations can give the observed law for the partition of energy among a large number of degrees of freedom; but these proofs make use of exact conservation, and fail if it is denied; so the denial makes it far more possible to believe in the continuity of Nature. In the course of various discussions it has been suggested to me that it would be more satisfactory to suppose that energy was exactly conserved, but could become latent. It is difficult to see what advantages such an idea can have; but, at any rate, there is an essential difference in it, for it would imply that the total apparent energy of an enclosed system will fluctuate about a *fixed* average value, whereas in the case of a statistical balance it may slowly wander away from the initial value and will exhibit no tendency to return to it. Of course the wave equations possess an energy integral, and so acceptance of the wave theory implies conservation of energy in free space; it is for interaction with matter that it need not hold.

The principal point which I wish here to make is that a mere acceptance of the wave theory implies certain important consequences, which must follow no matter what is the nature of the reaction between waves and matter—consequences which have perhaps not always been fully appreciated. The starting-point is that when a light wave acts on matter there is certainly a reaction on the light and that it is inconceivable that this should be anything but a spherical wave issuing from the matter. Now consider what happens when light is absorbed. Evidently the molecules must give out waves of such a type that the transmitted light is reduced in intensity, and the diminution can only arise through the interference pattern composed by the plane and the spherical waves round about the produced direction of the incident beam. Moreover, the reduction is only possible if *there is some phase relation between the incident and the emitted light.* Examined from any other direction there will be no interference and the matter will appear to emit light—in other words, there must certainly be a scattered wave. It can be shown without more specific hypothesis that its magnitude is related to the optical constants of the matter in much the same way as it is in the classical theory. To any one accustomed to thinking only in terms of the electromagnetic theory there will be nothing remarkable in all this, though it is worth noting how much more general it is than the electromagnetic theory; but I have never seen the point mentioned in connexion with the quantum theory, and it appears to me that this scattered wave, having a phase relation with the incident and determining the balance of energy, is one of the most essential features to be watched in any attempt to work out a quantum theory of absorption.

In my former letter a similar argument led to the dispersion formula. Dispersion is more or less adequately described by the classical theory, provided that the electrons are supposed to be retained with such forces that in a free vibration they would emit light of frequency corresponding to some spectrum line. On the other hand, this line can only be described in terms of the quantum theory by the difference between the energies of two stationary states. Now the most striking merit of the Bohr theory was that it gave a simple physical meaning to the "terms" of the spectrum line, and the meaning ought also to apply for refraction. For this reason I tried the idea that an atom could only give out a standard type of wave, intending it to be the same wave as in a free emission, and was much surprised to find how easily this led to the ordinary dispersion formula. In a private letter Prof. Bohr pointed out to me an objection which makes it impossible to maintain the hypothesis in this simple form, because if the standard wave were as large as is indicated by the quantum theory, it would not explain the refraction of very faint lights. He has since published the same criticism in *Zs. f. Ph.*, vol. 13, 3, p. 117. I had overlooked this important point, but after writing the letter I came across another result which suggested the need for modification. This was that the intensity of scattering of hard γ-rays would be proportional not to the intensity, but to the amplitude of the incident rays. This seemed a very improbable result, but not quite inconceivable in view of the well-known difficulties about the scattering of γ-rays. In the course of a visit which I paid to Montreal, Dr. J. A. Gray, of McGill University, who is familiar with such work, very kindly agreed to examine the question experimentally, and has since informed me that he has verified that the scattered intensity is proportional to the incident intensity.[1] In the meanwhile it was evident that a simple modification of the hypothesis would meet the difficulty, and it also meets Prof. Bohr's objection. It was before assumed that the scattered light depended on the product of two factors. One of these was the probability of excitation, proportional to the rate of change of the incident electric force; this I called $A_n(\delta E/\delta t)dt$. The other was the amplitude α_n of the standard wave. It is only necessary to alter the assumptions by taking $A_n dt$ as the probability and $\alpha_n(\delta E/\delta t)$ as the amplitude of the scattered wave for both objections to disappear. The excited wave is still characteristic of the atom in frequency and phase, but its amplitude is proportional to the incident wave. This is the form of the theory with which I have since been working. But the failure of the standard wave is a very severe blow to accepted ideas of the quantum theory. It is not possible to suppose that the atom goes right into its upper quantum state; but instead we are forced to believe that the atom, so to speak, knows what the upper state is like without going there, and the exact opposite of this is one of the greatest merits of the Bohr theory. We must now believe (and the same conclusion can be drawn from the views of Bohr in the paper already cited) that the two stationary states associated with a spectrum line have a much more intimate connexion than is suggested by the theory of emission, a connexion of which their dynamical formulation gives no hint; and once this is admitted it becomes very questionable exactly what the physical nature of the states may be, and how much further we may depend on the simple ideas hitherto in vogue.

The necessary abandonment of the standard wave destroyed the strongest argument for my hypothesis, as it could no longer unite the classical theory with the simple form of the quantum theory. Nevertheless it seemed well worth while to follow it up, for it explains interference while departing very widely from the difficulties in which the classical theory is involved. In the course of later work it has appeared that all the ordinary phenomena of optics are given quite satisfactorily, including dispersion, metallic reflection, optical activity, X-ray reflection, and scattering as exemplified in the light of the sky. The theory gives a straightforward interpretation of one of the two effects recently discovered by Clark and Duane (Proc. Nat. Acad., vol. 9, p. 126 and p. 131). For the "X-peak" I know of no explanation, but the other effect strongly suggests that white X-rays can excite the characteristic radiations of the atoms of a crystal *in phase*. In this instance I think my hypothesis has very distinct advantages over the classical theory, but it would be premature to discuss

[1] The test consisted in varying the distance of the source—changing its amount would not have done.

the matter here. What may be called second order scattering does not work very well on the hypothesis, but neither does it on the classical theory. Rather perversely the phenomenon which causes almost insuperable difficulty is the one which is most satisfactory on either the classical or the quantum theory, and that is the phenomenon of resonance radiation, as exhibited in Wood's work with mercury vapour. On my hypothesis the vapour ought to be excitable by light of wave-lengths different from its own, instead of requiring a very exact adjustment in the incident light, as it in fact does. It seems possible that a satisfactory modification of the hypothesis might result from a study of this failure.

In connexion with resonance radiation it is worth raising the question of whether the resonant light has a phase relation with the incident. In the quantum theory it is always assumed that it does not, but there does not seem to be much direct evidence. As pointed out above, there must be some light scattered in the process of absorption, and this light must have a phase relation, but it would depend on the phase difference whether this is the observed light or only a much weaker emission of the same frequency. I suppose the balance of evidence is rather against the phase relation; on that side there is the fact that one line of the spectrum can excite the emission of others, and there is some indication of the existence of a considerable latent period. On the other side any form of the wave theory requires that at least a part of the scattered wave should be in phase, and there is also some support, though not very strong, in Wood's recent discovery that the light is nearly completely polarised. Perhaps the work of Clark and Duane may also be invoked on this side.

As general conclusion the argument shows that the physical picture associated with the present quantum theory can be valid only over a very limited field, and that the more satisfactory parts of the electromagnetic theory can be taken over by a wave theory freed from many hampering restrictions.

C. G. DARWIN.

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Pasadena.

The so-called "Baccy-juice" in the Waters of the Thames Oyster-beds.

DURING May or June the waters over the oyster-beds at various places in the Thames estuary become periodically brown-coloured. This brown coloration is called "baccy-juice" by the local fishermen, who have connected with it such important observations on fisheries that its nature is worth recording. By the courtesy of Major A. Gardner and Mr. Louis French, I obtained on May 24 and May 28 tow-nettings and living samples of the "baccy-juice" from off Whitstable and off West Mersea, and find, as surmised, that the brown coloration is due almost entirely to the presence of great numbers of the spherical colonies of the brown flagellate Phæocystis. It is well known that Phæocystis occurs periodically in the English Channel and in the North Sea, and it is not surprising that it should occur in a similar way in the Thames estuary. The occurrence of "baccy-juice" in the Thames estuary is not welcomed by the fishermen (excluding oyster fishermen), who say that it is useless trawling for fish in the locality of this material, and also state that a cold spell of a few days is sufficient to cause it to disappear; these apparently good practical observations are well worth recording.

The Phæocystis from both sides of the Thames estuary, it is interesting to note, were carrying on each colony two or three individuals of a species of Acineta, closely allied to if not identical with *Acineta tuberosa*, var. *fraiponti*, which is taking advantage of the floating Phæocystis to adopt a planktonic and semi-parasitic habit.

A brown coloration of the water over oyster-beds in the riverine portion of estuaries is also very common in summer and autumn, but in the rivers Yealm and Helford and in the Hamoaze estuary this colour is due almost entirely to various peridinians, which constitute a very large proportion of the diet of oysters at this time. In an estuary more open to the influence of the sea, where high salinities probably occur, as at Padstow, a brown coloration in autumn was found to be due to enormous quantities of a species of Chætoceras. In July 1922 the slight brown coloration of the water over the oyster-beds in the West Mersea creeks of the River Blackwater was due to a variety of diatoms, among which *Leptocylindrus danicus*,[1] Cleve, was the most common; but at the same time the diatom, *Nitzschia closterium*, was the dominant and almost the only floating form in those stagnant or semi-stagnant oyster-pits which had mud on the bottom.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, May 28.

The Relation of the Critical Constants and the True Specific Heat of Ferromagnetic Substances.

A MAGNET should have, like a fluid, three critical constants—a critical temperature, a critical intensity of magnetisation, and a critical field. The critical temperature and the critical intensity may be experimentally determined; the critical field is more difficult to find by experiment, but it may be calculated from the other two critical constants. When this is done for iron, cobalt, nickel, and magnetite it is found that the critical fields are very simply related to one another, being almost exactly in proportion to the numbers 1·0 (1·5), 2·0, and 3·0 respectively.

Further, these numbers are inversely as the true specific heats of these substances at their critical temperatures, and the product of the critical field and the true specific heat must therefore be a constant. For iron this constant is 0·0225, for cobalt 0·0230, and for nickel 0·0225; for magnetite it is 0·0691, but if this is divided by 3, the number of atoms of iron in the molecule, the result again is the number 0·0230.

The critical field is calculated as $\theta/8I_0$, where θ is the absolute critical temperature, and I_0 the maximum intensity of magnetisation; and hence the true specific heat multiplied by the ratio θ/I_0 is $0{\cdot}0225 \times 8$, that is, 0·18. Now this number is, to a close approximation, five times the energy per unit of temperature for one degree of freedom calculated from R, the gas constant, and the atomic weights of the ferromagnetic metals, and this points to the specific heat at the critical temperature as that corresponding to five degrees of freedom. As there are three degrees of freedom in the calculation of the specific heat at air temperature, there must be an acquisition of two degrees of freedom at the critical temperature, a conclusion which has been reached by a different method, and was the subject of a letter printed in NATURE of July 1, 1922 (vol. 110, p. 10).

The result stated above may be put in another way by saying that the thermal energy at the critical temperature and the maximum intensity of magnetisation of the ferromagnetic substances are proportional to one another.

[1] I am indebted to Dr. M. V. Lebour for this identification.

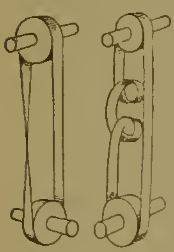
Some relation of this kind was surmised by Faraday, who wrote: "My impression has been that there was a certain temperature for each body (well known in the case of iron) beneath which it was magnetic, but above which it lost all power; and further, there was some relation between this *point* of temperature and the *intensity* of magnetic force which the body when reduced beneath it could acquire" (*Phil. Mag.*, 1836, vol. iii. p. 177).

J. R. ASHWORTH.

55 King Street South, Rochdale,
May 5.

A Puzzle Paper Band.

SOME thirty or forty years ago geometricians were much interested in the endless band of paper to which one half twist had been given before joining the ends. This gave the figure having only one surface and one edge. At that time those who studied this figure were so obsessed with the consequence of cutting down the middle line of such a band or of a band with two or more half twists that I believe no one noticed the result which I wish now to describe. It is the doubling up in a proper manner of an endless band to which four half twists have been given so as to produce the endless band first described but of double thickness. The first band is shown at A, as an endless belt connecting two crossed shafts for which, as is well known, it is exactly fitted. B shows the band with the four half twists all on one side in the form of two complete loops, and to be uniform with the other it is shown as an open band connecting two parallel shafts. The only object of putting in the shafts and pulleys is to assist the perspective. They are not wanted in making the experiment. Now if B, which appears sufficiently uncompromising, is folded up properly it becomes A but of double thickness.



A B

I used this doubled A for a time as a record sheet for my recording calorimeter, for, having a head-room to work in of four feet and a movement of paper of six inches a day, I was able in this way to obtain a continuous record for 32 days on one side of the paper only. This is superseded now by a more convenient arrangement.

It may be worth while to add that while lying awake one night I visualised A in two thicknesses and saw it to be what I wanted, and the next day I found it all right. What I did not visualise was the puzzle that it is to fold up B into an A of double thickness, and that it makes a first-class parlour puzzle game. It has this further advantage that a number may be made, some with right-hand and some with left-hand twists, so that any preliminary success gained on one may make the other seem the more difficult. The band should be not less than 50 times as long as it is wide.

Of the four half twists two are easily seen in the finished double thickness band, for each thickness has one half twist; it is amusing to find out where the other two have gone. C. V. BOYS.

The Viscosity of Liquids.

IN NATURE for May 5, p. 600, Prof. C. V. Raman writes: "I have suggested that the viscosity of liquids and its variation with temperature may be explained on the hypothesis that the liquid state of aggregation is composite in character; that is, is composed in part of molecules 'rigidly' attached to each other as in a solid, and in part of molecules which are relatively mobile as in the gaseous state (NATURE, April 21, p. 532)."

The above hypothesis was suggested by me in a paper which appeared in the *Phil. Mag.* for Feb. 1888, p. 156. In solids the atoms or molecules, in normal conditions, are, in the majority of instances, adhering to each other, and if, owing to vibratory movements within the mass, the adhesion should be broken anywhere, the *same bond* is quickly restored if the mass be only moderately strained. If, however, the mass should be in a state of considerable strain, broken bonds may make new attachments, and the solid be permanently deformed. In the case of liquids, although the majority of the molecules are bonded by chemical forces, a number, depending upon the temperature, etc., are continually breaking bond, even in the absence of strain. but, instead of again remaking the original bonds, they may form *fresh bonds*. In the paper already quoted, p. 160, I remark: "Gravity may, therefore, give rise to a slow but continuous change of form in an elastic substance in the interior of which liquefaction and resolidification are constantly going on." The theory, particularly as regards ice, was afterwards developed in some detail, and I should like to invite attention to a paper on "The Viscosity of Ice," Proc. Roy. Soc. A, vol. 81, 1908, p. 250.

Irving Langmuir (Jour. Amer. Chem. Soc., vol. xxxix., Sept. 1917, p. 1858) also advances the same idea. He remarks: "The mobility of a liquid is thus due to a shifting of the relative positions of atoms which are all chemically combined with each other."

R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey,
May 14.

Perseid Meteors in July 1592.

IN NATURE of November 18, 1922 (vol. 110, p. 667), there appeared a letter from Mr. H. Beveridge, directing attention to a statement by Abūl Fazl that "on the 27th day of Tir O.S., which might correspond to about July 28, 1592, three hundred little stars or pieces of stars (*sitāracha*) were seen traversing the heavens from west to east." The date, Tir 27, belongs to the Târîkh-i Ilâhî, or Divine Era, which was used by Abūl Fazl, and must not be confounded with other calendars in which the same month names occur.

In a study assisted by Mr. Beveridge's courtesy I have examined a large number of dates belonging to this era, and I find that each year was made to begin at the sunset following the vernal equinox, and, so far as the dates can be tested by the days of the week or by an astronomical phenomenon, each month would appear to have been made to begin at the sunset following the entrance of the sun into a sign of the zodiac. There is one instance, however, where a month is made to begin one day earlier than it should according to this rule. According to this rule Tir 27 should begin at the twenty-seventh sunset after the summer solstice, which in the year 1592 would be on July 7 of the Julian calendar or July 17 of the Gregorian calendar, and I infer that the meteors were observed on the night of July 17-18 of the Gregorian calendar. There is no reason to suspect an error of more than one day in this date. In his translation of Abūl Fazl's Akbarnāma Mr. Beveridge identified Tir 24 of that year with July 4 of the Julian calendar, and I take it that July 28 in his letter to NATURE was a *lapsus calami*.

In the *Observatory* for May 1923, p. 169, Mr. W. F.

Denning examines the dates of abundant showers of Perseids and finds that a large proportion of them can be satisfied by a period of 11·75 years. This period would give an abundant shower for the year 1592, and Mr. Denning has included that year, apparently on Mr. Beveridge's authority, in the list of years of observed maxima. A list of Perseid showers, or at least of showers at the time of year when Perseids are expected, is to be found in Arago, "Astronomie populaire," iv. p. 296-8, and is extracted from Biot's "Catalogue général des étoiles filantes . . . observés en Chine," published in *Mémoires présentés à l'Academie, sciences math. et phys.*, x., p. 129, etc. To these Chinese observations it is possible to add one from Matthew Paris of the date 1243 July 26. The complete series then becomes: 714 July 15, 784 July 10, 830 July 22, 833 July 23, 835 July 22, 841 July 21, 865 Aug. 1, 924 July 21-23, 925 July 22, 23, 926 July 22, 933 July 20-25, 1243 July 26, 1451 July 27, all Julian dates.

An analysis of the dates of the medieval observations shows that the date of maximum intensity of the Perseid shower has not shifted its position in the sidereal year since the year 830 at latest. The date corresponds to a solar longitude of 138 reduced to the equinox of 1900. A few of the showers recorded in history fall a little before or after that date, and in two instances (784 and 865) the difference is as much as ten days on either side of the normal maximum. In 1592, on the other hand, the recorded shower falls nineteen days earlier than the normal maximum, and this raises a doubt whether it was really a Perseid shower at all or some otherwise unknown shower which happened to fall in a year when an abundant Perseid shower was due. J. K. FOTHERINGHAM.

University Observatory, Oxford,
May 21.

The Measurement of Overvoltage.

IN general, the term overvoltage refers to the difference between the potential required to discharge an ion at a particular electrode and the calculated reversible value, in the same electrolyte. Strictly speaking, therefore, overvoltage only exists while the current is flowing, and hence measurements should be made under these conditions. Some workers, however, state that the "transfer resistance" of a gas film at the electrode causes the measured potential to be in excess of the true value; consequently, an alternative method has been adopted in which a rotating commutator rapidly interrupts the polarising current and connects the experimental electrode with the potentiometer system. In this way disturbing influences due to transfer resistance are said to be eliminated, since the potential of the electrode is measured when the current is not flowing. This method gives lower results than the direct method for the following reasons: (1) When the polarising circuit is broken, an extremely rapid fall of potential occurs, which is appreciable even in the small interval that elapses between the periods when current flows; (2) since the current only flows intermittently through the experimental cell, current density and time effects are not comparable with those obtained when the current flows continuously; (3) the continual make and break of the circuit by the commutator sets up alternating induced currents, and it is well known that electrical discharges of such a nature tend to lower the potential of a polarised electrode.

In some recent work, hitherto unpublished, the magnitude of the effects due to these induced currents has been investigated. The lowering of potential was found to depend upon the particular electrode examined, and was usually of the order of 0·3 volt, and in some cases as much as 0·5 volt. The value of the induced current, and consequently its effect on the potential, will depend on the frequency of the intermittent current, and upon the resistance and self-inductance of the circuit; but it seems fairly certain that the lowering of potential, due to induced currents in the commutator method for measuring overvoltage, is considerable.

In order to eliminate as many sources of error as possible, the following method for the measurement of overvoltage is being tested. The commutator method is being used, but a "choking coil" of high self-inductance is placed in the circuit in order to reduce the induced current to a negligible amount. Further, instead of the polarising and potentiometer circuits being made for equal intervals of time, the latter will only be complete for about 10° in each revolution. Thus for about 97 per cent. of the time the polarising current will flow through the cell, and, if the commutator revolves 3000 times per minute, only 0·0007 seconds will elapse between opening and closing the current circuit. To ascertain the magnitude of the fall of potential during this period, further experiments will be made, either by varying the speed of the commutator, or by increasing the period per revolution in which the experimental electrode is connected with the potentiometer system. By extrapolation, it should be possible to determine the potential of the electrode at the instant of breaking the current, and the results compared with those obtained while current is still flowing, in order to determine the effect of the so-called "transfer resistance." S. GLASSTONE.

University College, Exeter,
May 22.

A New Phototropic Compound of Mercury.

IN an attempt to prepare the phototropic compound, dimercuric-diiodo-disulphide, described by Dr. Ray (Jour. Chem. Soc. 1917, T, 101-109), we accidentally discovered a new phototropic mercury compound of the formula $Hg\langle^{HS}_{CNS}$ through a mistake of the laboratory attendant in supplying us with potassium nitrate in the place of the nitrite. The compound is prepared by the interaction of a mercuric salt with ammonium sulphocyanide and thio-urea in a solution of acetic acid in the presence of an oxidising agent. The compound is also prepared by the action of hydrogen sulphide on mercuric sulphocyanide. This gives us a clue to the constitution of the yellow mercuric compound.

The compound is very phototropic, inasmuch as it is effected by strong sunlight in less than 1/60th of a second and by diffused daylight in a few seconds. It appears, therefore, to be the most phototropic compound as yet known. In researches on this compound we have prepared a red variety of mercuric sulphide by precipitation methods. Again, by the decomposition of the yellow mercuric compound, we have prepared a yellow variety of mercuric sulphide which shows interesting thermotropic properties. By the action of free iodine on the new phototropic compound, an iodine compound of mercury which is also phototropic has been prepared. Further work is in progress. Y. VENKATARAMAIAH.
BH. S. V. RAGHAVA RAO.

Research Laboratories, Maharaja's College,
Vizianagram, May 9.

Ancient Egyptian Chronology.

By Dr. H. R. HALL.

WHEN one is told that Tutankhamen, the Egyptian king, the discovery of whose tomb, followed by the tragedy of Lord Carnarvon's death, has aroused such widespread interest in ancient Egypt, reigned roughly between the years 1360 and 1350 B.C., it is naturally asked by many how this is known with such certainty? The Egyptians had no regular era. They merely spoke of such-and-such a year of King X. The Assyrian, however, possessed a continuous era, of which each year was noted by the name of an eponymous official. The definite fixing of this Assyrian era has been due to the help of astronomy. In a certain eponymy of the eighth century B.C., an eclipse of the sun is recorded as having taken place in the month Sivan (May-June). This has been reckoned astronomically to have taken place in 763 B.C. All other evidence of the kind fits in with and confirms this: the eponym-dates are certain to the actual year so far back as 893 B.C., when the later Assyrian series began, and are also now certain to within a few years at a much earlier period. So far back as the ninth century, at least, then, we can fix Egyptian dates with the aid of Assyrian synchronisms, and we find that Shishak I., the conqueror of Jerusalem, must have reigned about 930 B.C., which is not so different from the old traditional biblical date of 975 B.C.

Besides having no era, the Egyptians took no notice of eclipses. They did, however, possess an "epoch" which was based on astronomical observation: the "Sothic cycle." At an early period, apparently in the year 4241 or 4238 B.C., the Egyptian calendar was fixed to begin with the first day of the first month on the day of the heliacal rising of Sothis or Sirius. The year consisted of 360 ordinary days + 5 epagomenal. The necessity of intercalating a day every fourth year was not noticed. Hence, as time went on, the months lost all relation to the seasons, and the heliacal rising of Sirius would not correspond again with the first day of the year until a whole cycle of 1460 years had been completed. This cycle was recorded, but only used for calendrical purposes, never for dating events.

We know from classical sources that a new "æon" or cycle began in A.D. 139 or 143. The Alexandrian mathematician, Theon, called the beginning of the preceding cycle, which began in 1321 or 1317 B.C., the "era of Menophres." Now we know from synchronisms with Babylonian and Assyrian history, as well as from dead reckoning of the length of reigns, checked by the statements of Manetho (the Egyptian historiographer who lived in the third century B.C.), that roughly about 1321–1317 B.C. must have fallen the short period between the Egyptian kings Harmais (Harmhab) and Seti I., the end of the XVIIIth and the beginning of the XIXth Dynasty of Manetho; and between them reigned Rameses I., whose second name was Menpehre. Evidently he is Menophres, and the beginning of the era and the date of either 1321 or 1317 B.C. must have fallen in his reign. With this conclusion all the other evidence agrees.

Reckoning back from this date, we find that the dates of certain new-year festivals that are recorded on certain days of the month in certain years in the reigns of Thutmases (Tethmosis or Thothmes) III., and Amenhatpe (Amenophis) I., predecessors of Menophres, can be fixed to the years 1474 or 1470, and 1550 or 1546 B.C. The date for Thutmases III. is confirmed by the identification of two new-moon festivals recorded on certain days of the month in two stated years of his reign as those of May 15, 1479, and February 23, 1477 B.C. Our very full knowledge of the history of this time (the XVIIIth Dynasty) enables us to say definitely that these dates correspond to what a dead reckoning of the kings' reigns back from Menophres would demand. Also they fit in absolutely with the dates, based ultimately on the eponym-lists, demanded for Babylonian and Assyrian history at this time, when synchronisms with Egypt were frequent. Computing further back from the reign of Amenhatpe I. we find that I'ahmases (A'ahmes or Amosis) I., his predecessor, and the founder of the dynasty, must have ascended the throne within a few years either way of 1580 B.C.

So we know that Tutankhamen reigned about 1360–1350 B.C. He preceded Menophres by about thirty-five years, most of which was occupied by the reign of Harmais or Harmhab. The heretical king Akhnaten, the monotheistic worshipper of the god of the sun's disk, of whom there has been so much talk lately, and his father the great Amenhatpe or Amenophis III (Nibmare, the Mimmuriya of the contemporary Babylonians and Memnon of later Greek legend) will have reigned *circa* 1410–1360 B.C., the date also demanded by the synchronisms with Babylonia.

I have implied that no Egyptian dates earlier than 1580 B.C. are so certain as these. Of course there are the exceptions of the era-dates of 2781 (2778) and 4241 (4238) B.C. But we do not know what kings were reigning at these dates. Amosis, I imply, is the first king of whose date we can be certain; but this view is not universally held by Egyptologists. Some would go further back, to at least 2000 B.C. for certain dates, which are again deduced from the Sothic reckoning, on the following grounds.

In a papyrus of the XIIth Dynasty it is stated that Sothis rose heliacally on a certain day of a certain month in the seventh year of King Senusret III. German investigators have computed this date at 1882 (1878) or 1876 (1872) B.C.; but from the same data a British computer, Mr. Nicklin, has arrived at the date 1945 B.C. There is, therefore, evidently some room for doubt in the matter.

The German date is, however, generally received, and the XIIth Dynasty therefore currently ascribed to the period 2000–1788 B.C. But, apart from the fact of Mr. Nicklin's varying computation this date has seemed to several, including myself, to be open to serious objection, because it does not allow sufficient time for the XIIIth Dynasty and the period of the Hyksos kings. We have an Egyptian record of the kings, the Turin Papyrus, which gives a long list of the monarchs of this period, though without dates. Manetho, the Ptolemaic historiographer (or his commentators) assigns a lengthy period of time to this age. Yet the evidence from Crete is in favour of a short period, and would not disagree with the German dates. That of Egyptian archæology and art is also in favour of the shorter dates, yet scarcely for so short a period as a bare two hundred years. We have, too, so many contemporary records of kings of this time (apart from the evidence of the Turin Papyrus) that we cannot suppose that only two hundred years elapsed between the end of the XIIth and the beginning of the XVIIIth Dynasty. The Hyksos period alone can, one would think, scarcely have occupied less than two centuries.

So impressed is Prof. Flinders Petrie by these arguments (and others) that he boldly supposes that we must put the XIIth Dynasty back a whole Sothic period in time, and make Senusret III. reign about 3300 instead of about 1900 B.C. He has not been followed in this cutting of the Gordian knot, for few will believe that 1600 years can have elapsed between the two great dynasties, which on the ancient monumental lists of kings at Abydos and Sakkarah are immediately coterminous, the Hyksos and their predecessors being regarded either as usurpers or of no account. Prof. Capart is the only Egyptologist who seems inclined to go somewhat in the direction of supporting Prof. Petrie, but he must do so at the expense of abandoning the astronomical calculation, which Prof. Petrie accepts.

Personally, being unable to believe either that so few as 200 or so many as 1600 years separated the two dynasties, I can only suspend judgment until the astronomers have examined the question and the evidence anew and have recalculated the date indicated by the observation in Senusret's reign. Until then I can only suppose that some mistake either in ancient observation or modern calculation has occurred, and adopt provisionally the very round date of *circa* 2000 B.C. for the end of the XIIth Dynasty, which would satisfy most historical, archæological, and artistic demands.

This date would give the Middle Kingdom (XIth–XVIth Dynasty) the date *circa* 2350–2000 B.C. We know the lengths of the reigns of the kings of the XIIth Dynasty accurately from contemporary monuments, and Manetho combined with the monuments gives us an adequate idea of the XIth.

Now the Turin Papyrus becomes important. Its regnal years for the Old Kingdom (Dyns. I.–VII.) are often useful, in conjunction with Manetho and the monuments, and it gives the definite sum-total of the reigns of this period as 955 years. Allowing about 150 or 200 years for the IXth and Xth Dynasties (so far as they were not contemporary with the VIIIth and XIth) and for the period of interregnum in art and civilisation which certainly elapsed between the VIth and the XIth, we can roughly date the Old Kingdom to the round date *circa* 3500–2500 B.C. The three conquerors of the North, the Scorpion, Narmerza, and 'Ahai, who seem to have become conflate in later Egyptian legend as Meni or Menes, the first king of all Egypt and founder of the Ist Dynasty, will then have reigned about 3600 or 3500 B.C.

This date is about two centuries earlier than that maintained by the Germans, who are followed by Prof. Breasted. Prof. Petrie, of course, in accordance with his theory, goes much further back, returning to the remote date of more than 5000 B.C. which used to be credited twenty or thirty years ago. Capart moves in the same direction, too far in my opinion, and relying somewhat on an interpretation of the evidence of the fragments of the Palermo Stone (an ancient contemporary monumental chronicle of the time of the Vth Dynasty) put forward by Borchardt, which has been shown to be misconceived and untrustworthy by Prof. Peet.

The predynastic period, when there existed two independent kingdoms, if not three, in Egypt, which had arisen out of neolithic primitiveness, will then date to any length of time before 3500 B.C. that one may be inclined to credit. The institution of the fixed calendar in 4241 or 4238 B.C. will have been the first important sign of civilisation in Egypt.

Such, explained as succinctly as possible consistently with intelligibility, is the evidence on the subject of ancient Egyptian chronology. If the astronomers will turn their attention to the Kahun date and recompute it, and also tell us whether any ancient mistake is possible and of what kind, we shall all be better able to make up our minds on the subject of the dates before 1580 B.C.

That there is room for a recomputation is shown by the divergence of the calculations of Mr. Nicklin and of the Germans. That doubts of the necessary validity of all astronomical calculations of this kind are not altogether mistaken seems to be shown by the fact that the astronomical fixation of certain early Mesopotamian dates by Kugler, which has been accepted for several years past, is now discredited by many Assyriologists on the authority of the newly-discovered Assyrian king-lists and on account of the fact that Kugler's calculations, I understand, place the harvest season at an impossible time of the year. These doubters would bring the epoch of Hammurabi down again to nearly the date originally advocated by the late Prof. King before he accepted Kugler's results.

The 800th Anniversary of the Foundation of St. Bartholomew's Hospital.

In the long history of St. Bartholomew's Hospital, now extending over eight hundred years, during which the gates have never been closed or the wards entirely empty, many men have served the Charity well and faithfully. The exacting nature of the duties required of those attending upon the sick do not leave much time for speculative science, but the staff of the hospital has always been foremost in advancing the art of physic. The hospital was founded in 1123; and the celebration of its eight hundredth anniversary is being held this week. It was founded upon a religious basis and was placed in charge of a master, eight brethren and four sisters of the Augustinian Order. They had no science, but the scanty records of the treatment adopted shows that common sense prevailed and the experience gained was sufficient to build up a great tradition of practice and nursing.

The religious foundation lasted uninterruptedly for four hundred years until the Reformation led to a reconstruction. The enlightened policy of the citizens of London prevented spoliation and wholesale destruction, so that the Charity as it exists to-day still retains some of its original archaic characteristics. A succession of great surgeons—Vicary, Gale, Clowes, and Woodall—held office in the hospital under the later Tudor sovereigns. They were men who had gained their experience in the foreign wars and had served so far afield as Poland and Russia. Rough, practical surgeons, they concerned themselves with the sick and hurt and in an abortive attempt to raise their own professional status. Of science they knew nothing. It was slightly better, perhaps, on the medical side. Dr. Timothy Bright did some service when he invented his system of shorthand, but the discoveries of William Gilbert in magnetism seem to have been entirely unknown to them, although as members of the same profession and of the same college, living together in a small town, they must have been constantly in association with him. The governors of the hospital would indeed have done themselves great honour had they chosen him as their first physician under the new foundation instead of electing one who was afterwards hanged, drawn, and quartered for conspiring to poison Elizabeth.

The real scientific history of the hospital begins with William Harvey, appointed physician in 1609, who announced his discovery of the circulation of the blood in the Lumleian lectures at the College of Physicians in 1616. The discovery revolutionised the practice of medicine and made possible an experimental physiology. The very simplicity of the proofs were a stumbling-block to his contemporaries, but the teaching was eagerly accepted by the younger generation, those founders of the Royal Society who formed so wonderful a band at Oxford and in London just after the Restoration.

When Harvey died, the mantle of science in the hospital fell sometimes on the medical and sometimes on the surgical side of the house. Percivall Pott began to teach surgery systematically, and his lectures were attended by John Hunter, the founder of scientific surgery in England. The pupils of Pott followed each other in a long succession as surgeons to the hospital and *quasi cursores* handed on the Hunterian teaching to our own day. Earle and Abernethy, Lawrence, Savory, and Butlin bridged the interval between the death of Hunter and the dawn of Lister. But, as in the time of Harvey, the older teaching had become so ingrained in the school that it was found difficult to accept the doctrine of the germ theory of disease and the revelations of antiseptic surgery. It was not until a new generation came into its own that men like C. B. Lockwood entered whole-heartedly into the promised land of Listerism, and Klein, Kanthack, and Andrewes advanced the great science of bacteriology.

Until 1836 the teaching of chemistry was in the hands of the physicians to the hospital, but from that time onwards it became specialised and the school was fortunate in obtaining a regular succession of first-rate teachers; Brand, Stenhouse, Frankland, Abel, Odling, Russell, and Chattaway followed each other, the students were well taught, and some opportunities were afforded for original work. In like manner, Sir Lauder Brunton, before he became physician to the hospital, was a pioneer in experimental pharmacology, and in that branch of knowledge which has since developed into bio-chemistry. Between 1882 and 1912 Steavenson and Lewis Jones by their work at the hospital raised medical electricity from a scientific empiricism to its position as a recognised branch of medicine. Lewis Jones, indeed, in his all too short life fairly earned the title of "the Father of Medical Electricity."

A great hospital leads to advances in many departments of science. New problems are constantly presented; the permutations and combinations arising in the complex structure of the human body are endless and the chemist and physicist are often able to give material help in placing medicine upon a firm basis of fact.

The Complete Gasification of Coal.

By Dr. J. S. G. THOMAS.

IT is well known that the percentage thermal efficiency of gas production from coal can be increased by gasifying the coke resulting from the high temperature carbonising process, and various processes and plants for effecting this conversion have long been available. Shortage of fuel supplies during the years of the War, and afterwards, resulted in the Board of Trade issuing instructions to gas companies to "stretch" their supplies of gas. The "stretching" process intended was to consist of a reduction of calorific power of the gas supply, accomplished by dilution of straight coal gas with either blue or carburetted water gas. The attention of the industry in all countries was, at the time, naturally directed towards increasing the efficiency of production of water gas and its efficient utilisation admixed with coal gas in a towns' gas supply. In England considerable work on these lines was done by George Helps, the "big noise" of Nuneaton.

Much publicity has recently been given to a plant designed by C. B. Tully, and operated at Bedford, for the complete gasification of coal. Altogether, since 1919, about two hundred such plants have been erected in this country, the largest being installed at Halifax, which is capable of producing about 7000 therms per day. The installation at Bedford comprises two sets, each capable of producing about 2500 therms per twenty-four hours. The average percentage composition of the gas is approximately CO_2, 5; N_2, 5; O_2, 0·5; CO, 36; H_2, 45; CH_4, 8; C_nH_m, 0·5, and the calorific power is about 350 B.Th.U. per cubic foot. Bedford is supplied with a mixture of straight coal gas with about 51 per cent. of this gas, the resulting calorific power being about 460 B.Th.U. per cubic foot. Manufacturing costs in the case of the Tully plant are stated to amount to about 2·74*d.* per therm and the capital manufacturing charges to about 0·08*d.* per therm. The desirability or otherwise of the manufacture and distribution of this gas in any definite case must be determined by a variety of factors, among others by the size of the undertaking, local conditions as regards supplies of raw coal, characteristics of the demand for gas, storage capacity, and size of the distributing system. Increased costs must be incurred in the distribution of the gas compared with those incurred in the case of straight coal gas.

On one matter to which public attention has recently been directed we would remark that the possibility of converting the comparatively large percentage of carbon monoxide in water gas into carbon dioxide or methane is by no means a novel proposition either from the scientific or industrial point of view. Sabatier and his co-workers showed, many years ago, that in the presence of nickel, cobalt, or palladium, carbon monoxide and hydrogen at 230-400° C. react to form methane and water, thus: $CO + 3H_2 = CH_4 + H_2O$. This hydrogenation is subject to the important objection from the technical point of view that while hydrogen must be present in excess, an equal volume of hydrogen must be added to water gas to provide the mixture theoretically necessary. This hydrogen can be derived from water gas, and the net result is that the yield of methane is only about 15 per cent. of the total water gas employed. Sabatier pointed out that by passing water gas over nickel at 400-500° C. the following reaction occurred; $3CO + 3H_2 = CH_4 + H_2O + C + CO_2$. The carbon deposited on the catalyst may, at the same temperature, be caused to react with steam to form a mixture of hydrogen, methane, and carbon dioxide, whereby the catalyst is regenerated for use in the first phase of the process. Sabatier further suggested that both phases might be combined by passing water-gas and steam over a nickel catalyst at 400-500° C., when the following reaction occurs: $5CO + 5H_2 + H_2O = 2CH_4 + 2H_2 + 3CO_2$.

These various reactions are summarised in a recent paper by Drs. E. F. Armstrong and T. P. Hilditch, read before the Royal Society (see NATURE, February 3, p. 168), in which they direct attention to a reaction between carbon monoxide and hydrogen which has hitherto apparently escaped notice. They find that the action between equal volumes of carbon monoxide and hydrogen in the presence of nickel or a similar catalyst at temperatures below 300° is in the main represented by $2CO + 2H_2 = CO_2 + CH_4$. It will be noticed that the gases carbon monoxide and hydrogen participate in the reaction very approximately in the relative proportions in which they are present in blue water gas, (43 per cent. CO, 48 per cent. H_2). The reaction, though never complete, proceeds to a very considerable extent, and the authors consider the process may be of value in gas practice as the proportion of methane is 25 per cent. of the water gas decomposed, whereas by any of the other processes referred to the maximum possible yield is only 20 per cent.

The idea of the technical utilisation of the first reaction referred to above for the production of methane, and the application of the reversible reaction $CO + H_2O = CO_2 + H_2$ for the production of hydrogen has recently been revived in connexion with the Tully plants. It must be realised that little if any actual large-scale operations of this nature have hitherto been carried out. Considerable experience is necessary for the successful operation of catalytic plants operated at relatively high temperatures and dealing with the huge volume constituting a day's make of towns' gas in the case of even one of the smaller gas companies. It is contemplated that the plant required would be of the same nature as that designed for the catalytic purification of gas from sulphur compounds which is in successful operation in the works of the South Metropolitan Gas Company. Operating charges would possibly amount to about ½*d*. per therm. It is questionable whether it would be technically feasible to remove the carbon dioxide produced. A suitable catalyst has been prepared, and small-scale operations in a plant capable of treating 200 cubic feet of gas per hour have been carried out. Large-scale operations constitute a much more difficult proposition.

Obituary.

MR. F. W. HARMER.

BY the death on April 24 of Mr. Frederic William Harmer, within a few days of the completion of his eighty-eighth year, the county of Norfolk loses one of its most distinguished sons and East Anglia the penultimate survivor of a band of amateur and professional geologists to whom science is under deep obligations, not merely for the elucidation of local problems, but for the establishment of principles and of methods of research of European or even wider application.

Mr. Harmer, descended from a stock the most ancient in Norfolk, was early imbued with a love of science, especially of geology, and the fortunate chance of a meeting in 1864 with Searles V. Wood the younger directed his enthusiasm and energy along lines of research that, with one significant break, he followed to the end of his long and useful life. The two friends embarked upon the study of the records of the Ice Age, and, in pursuance of Wood's conviction that accurate mapping of the glacial deposits was essential to the decipherment of their story, the task—never before attempted—was undertaken, and in the course of a few years an area of 2000 square miles was mapped on the scale of one inch to the mile. Harmer's share was the county of Norfolk and the northern parts of Suffolk.

Wood told the present writer that the young officers of the Geological Survey with whom he was often in conflict ought to be grateful to him and his friend because their demonstration of the practicability of mapping drift deposits had compelled the Survey to increase its staff. Copies of the map, claimed by its authors to be the first of its kind ever produced, have been deposited in the library of the Geological Society and in the Museums at Norwich and Ipswich, and a lithographed reduction of the eastern portion was appended by Wood to one of the supplements to his father's great monograph of the Crag Mollusca.

The period of his association with Wood, of whom Mr. Harmer always spoke with touching reverence and affection, was brought to a premature close by the complete breakdown of Wood's health ending with his death in the early 'eighties. The loss of his friend and master acted as an effective damper upon Mr. Harmer's geological activities, and for more than a decade he threw his energies into business and the multifarious duties of municipal life.

The meeting of the British Association at Ipswich in 1895 was marked by the reappearance of Mr. Harmer, to the great surprise of a generation that had come to regard his work as finished. He presented two important papers upon the Coralline and Red Crags, which were received with great interest and attention by newcomers in the field of Pliocene geology and also by distinguished workers from France and Belgium present at the meeting.

From this time until the end of his life Mr. Harmer's interest and activity never flagged. He again took to the field and contributed many important papers to the Geological Society and other bodies. In Pliocene geology his achievements were many and valuable. The discovery of a deposit of Red Crag at Little Oakley, which yielded to his minute and pertinacious investigation a fauna of unparalleled richness, led him to a general review of the Pliocene geology of East Anglia, giving definiteness to the opinion long held by workers in that field that the deposits of Red Crag age marked successive stages in the withdrawal of the North Sea from south to north.

A discussion of the fragmentary Upper Tertiary patches of Lenham gave occasion for the correlation of the British Pliocenes with those of Belgium and Holland. His achievements in this field of study have the enthusiastic recognition of the geologists of Holland, Belgium, and France.

The remarkable contrast presented by the contemporary Pliocene deposits of the two sides of the North Sea in regard to the abundance of shells led to investigations of great moment. Premising that shells are cast up in profusion on the Dutch coast by the prevalence of onshore winds, Mr. Harmer showed that in Pliocene times the western shores received the shelly beaches. He proceeded from this to an elaborate discussion of the meteorology of the Pliocene and Glacial Periods, the first attempt by any man of science to apply the methods and results of modern meteorology to the solution of geological problems. This pioneer work has been followed up by many writers, notably in the recent book "The Evolution of Climate" by Mr. C. E. P. Brooks, to whom Harmer's work was apparently unknown.

The many additions to the Molluscan fauna of the Upper Tertiaries rendered necessary the resumption of the work of description interrupted by the death of the elder Searles Wood. Mr. Harmer undertook the task, and it is gratifying to know that shortly before the accident by which his death was accelerated he had revised the final proofs of the last of a series of supplements to the monograph on the Crag Mollusca published by the Palæontographical Society.

The great value of Mr. Harmer's work was recognised by his geological brethren; from the Geological Society he received the Murchison medal; he was elected successively Membre Associé Étranger and Membre Honoraire of the Belgian Geological Society; and the University of Cambridge conferred upon him the honorary degree of M.A.

Two of Mr. Harmer's sons adopted a scientific career, in which they have attained very high distinction; the elder, Sir Sidney F. Harmer, is well known as the director of the Natural History Department of the British Museum; the other, Mr. William Douglas Harmer, called at a very early age to the position of warden of St. Bartholomew's Hospital—always regarded as a presage of future distinction—is now the senior surgeon in the throat department of the hospital.

Percy F. Kendall.

Mr. M. de C. S. Salter.

The death on May 21, after a short illness, of Mr. Mortyn de Carle Sowerby Salter, at the early age of forty-two, removes from the scientific world an extremely able worker just at the moment when the mastery he had attained in his special field of study had brought him in sight of important achievements. The son of Mr. M. J. Salter, he was educated at Bancroft's school, and passed directly, at the age of sixteen years, to an assistantship in the British Rainfall Organisation under its founder Mr. G. J. Symons. Here he developed an aptitude for statistics and a patience with detailed routine which enabled him later to grasp the scientific principles underlying the distribution of rain and develop an enthusiasm for research combined with sagacity in the practical application of his knowledge.

Mr. Salter became my chief assistant at Camden Square in 1907, and from 1912 onwards relieved me of the whole responsibility for the accuracy of the annual rainfall tables in "British Rainfall." In 1914 he was appointed assistant-director and in 1918 joint-director of the Organisation, and on the transfer to the Meteorological Office of the Air Ministry in 1919 he became the first superintendent-in-charge, and was thus able to make the transition from private to official management easy for the five thousand voluntary observers.

Mr. Salter's health was always precarious, but he was nevertheless an indefatigable worker, and to the fact that no Medical Board would pass him for any form of military service is probably due the survival of the long-established system of rainfall investigation throughout the years of the War.

Mr. Salter served on the council of the Royal Meteorological Society and as a vice-president for many years; and he was an active member of the Institution of Water Engineers. He contributed numerous papers to these societies and to the *Meteorological Magazine*, of which he was joint-editor since 1913. He took a considerable part in the compilation of annual rainfall maps of the British Isles and of large-scale rainfall maps of many counties and other areas in co-operation with me, and after my retirement he carried the rainfall mapping of the country far towards completion. His little book "The Rainfall of the British Isles," published in 1921, gives an excellent account of the existing state of knowledge on the subject. In a paper on the fluctuations of annual rainfall considered cartographically, in collaboration with Mr. J. Glasspoole, read to the Royal Meteorological Society during his last illness, Mr. Salter gave an important discussion of the regional relations of rainfall and atmospheric pressure full of promise for future development.

For twenty-three years I found Mr. Salter a loyal fellow-worker and faithful friend, keenly intelligent, absolutely trustworthy, full of sympathy and consideration. I have pictured him writing my obituary notice; I never thought the natural order would be reversed. Hugh Robert Mill.

Prof. E. Hagen.

The issue of the *Physikalische Zeitschrift* for April 1 contains the account of the life and work of the late Prof. E. Hagen given by Prof. E. Gümlich at the meeting of the German Physical Society on March 9. Prof. Hagen was born at Königsberg on January 31, 1851, and losing his mother, who was the youngest daughter of Bessel the astronomer, in 1856, was brought up by a stepmother for whom he had a lifelong affection. On the removal of his father to Berlin he became a pupil at the local Gymnasium and in 1871 entered the University. After two years there he went to Heidelberg, where he graduated in 1875, having in the meantime acted as assistant to Bunsen. The next two years he spent at Dresden as assistant to Toepler and a further six as assistant to Helmholtz at Berlin.

In 1883 Hagen became a lecturer in the University of Berlin, and next year extra professor of applied physics at the Dresden Polytechnic. In 1887 he became physicist to the Navy and, removing to Kiel, acted also as extra professor at the University. In 1893 he became director of the technical section of the Reichsanstalt at Charlottenburg. He married in 1896 the daughter of Von Bezold the meteorologist, and in 1904 joined the staff of the German Museum at Munich. He died of inflammation of the knee on January 15. He was best known in this country for his work in conjunction with Rubens on the connexion between the electrical conductivity and the radiating and reflecting powers of metals.

It is with much regret that we record the death of Dr. Elizabeth Acton, on Sunday, May 13, after a prolonged illness. Dr. Acton was a distinguished student of the late Prof. G. S. West in the botanical department of the University of Birmingham. In 1908 she took her Bachelor of Science degree with honours, and in the following year received the M.Sc. for research work in botany. After that time she was almost continuously engaged in botanical research, and in 1916 was awarded the degree of D.Sc. (Birmingham). Her contributions to the study of fresh-water algæ are of outstanding value, and her work throughout was marked by great thoroughness and painstaking accuracy. Her early death has removed a devoted worker from the sphere of botanical research. Dr. Acton's activities outside her scientific work were necessarily limited, owing partly to her continuous ill-health and partly to her retiring disposition. She was a loyal friend, and her uncompromising honesty was one of her chief characteristics. J. S. B. E.
E. M. P.

We regret to announce the following deaths:

Prof. J. Chiene, emeritus professor of surgery in the University of Edinburgh and a friend and disciple of Lord Lister, on May 29, aged eighty.

Canon W. W. Fowler, president in 1901–2 of the Entomological Society, and author of "The Coleoptera of the British Islands," on June 3, aged seventy-four.

Prof. Franz Neger, professor of botany in the Dresden Technical College and director of the Botanical Gardens there, who worked with Baeyer for several years and published a thesis on dehydracetic acid, aged fifty-four.

Current Topics and Events.

The immense progress which has been made in the elucidation of crystal structure by means of X-rays, since the first discovery of von Laue at Munich in 1912, and especially the quantitative development which has afforded the absolute distances separating the atoms, their actual sizes, and the dimensions of the space-lattice cells, is largely due to the invention of the ionising X-ray spectrometer by Sir William Bragg. The brilliant use made of that instrument at University College, London, and latterly also by an increasing number of other workers in various parts of the world, has been the means of accumulating a surprising amount of knowledge of the structure and structural dimensions of a large number of substances, many of the more recently studied of which are no longer of the simplicity of those first submitted to investigation. It must prove of interest, therefore, to our readers that we are able to present, as a supplement to the present issue, a revised form of an admirable lecture which was recently delivered by Sir William Bragg to the Royal Society of Arts. The most noteworthy fact which emerges from the accumulated results, including those derived from the photographic method of Laue and the powder methods of Debye, Scherrer, and Hull, is that the conclusions of crystallographers, based on the most accurate crystal measurement and on the perfected geometrical theory of crystal structure, are proved to be correct, both as regards the nature of that structure, and its relative unit-cell dimensions in those few cases in which it had been possible to determine them. These relative dimensions are now converted into absolute values by the X-ray spectrometric measurements. The recent venture into the more difficult field of organic substances is adding a further chapter of exceptional interest, and is of immense importance both to chemistry and to optics. The results have already had the happy effect of restoring the molecule to its proper place in the solid state, from which only a misreading of the first few results with the simplest inorganic compounds had temporarily displaced it. Moreover, they have rendered it clear that the number, nature, and arrangement of the external electrons of the atom itself are involved in cementing together the parts of the crystal structure, so that further work is bound to throw light on atomic structure, and possibly to decide between, or combine the correct portions of, the rival theories concerning it.

Circular No. 137, issued by the Bureau of Standards, U.S.A., is the fourth of a series of circulars describing very simple radio receiving sets which were originally prepared for use by the Boys' and

Girls' Radio Clubs of the States Relations Service, Department of Agriculture. In Circular No. 120 it was shown how a single circuit and in Circular No. 121 how a double circuit crystal-detector set could be made out of ordinary domestic materials. It is now shown how the operation of either set can be improved by the use of a very simple and cheap condenser connected across the telephone receivers and a similar one connected in series with the antenna. Clear instructions are also given for constructing a simple loading coil so that longer waves can be received. The condenser in series with the antenna makes it easy to tune to wave lengths of less than 300 metres, whilst the condenser across the telephone receivers increases the intensity of the signals. The loading coil enables time signals, etc., to be received from high power stations. The parts for the auxiliary condensers cost about 80 cents, and the parts for the loading coli about 3 dollars.

Messrs. W. Heffer and Sons, Ltd., Cambridge, have just circulated a very full and useful catalogue (No. 224) of scientific books and serials numbering upwards of 2000 titles and classified under the headings of agriculture, husbandry, and farriery; anthropology and ethnology; botany; chemistry, chemical technology, and metallurgy; geology, mineralogy, and palæontology; zoology and biology; physiology, anatomy, and medicine; psychology and psycho-analysis portraits of men of science; and mathematics, physics, and engineering. The list is especially interesting from the fact that many of the works are from the library of the late Sir William Ramsay. We note that Messrs. Heffer are offering for sale in one lot a large collection of books, pamphlets, and serials dealing with aeronautics.

The cinematographic film, entitled "The Wonderland of Big Game," which Major A. R. Dugmore is showing at the Polytechnic Hall, Regent Street, London, is certainly one of the finest of its kind and deserves the attention of all interested in natural history. It is the result of a special expedition to East Africa made by Major Dugmore in 1922, and it is shown in connexion with a most charming and lucid explanatory lecture delivered by Major Dugmore himself. The outstanding merit of this film is its entire truthfulness and freedom from fake. It shows about thirty species, not only in their natural surroundings, but also under perfectly natural conditions, unharried by the big game hunter and usually unconscious of the presence of the harmless photographer. Save for occasional shots at lions, only one shot was fired at an animal during the expedition, and that was one intended merely to turn a rhinoceros from a headlong charge upon the camera. The animals are shown grazing at their ease upon the veldt, moving through the forest glades, or coming down to the water-holes to drink. The pictures of the common and Grevy's zebras, rhinoceros, elephant, buffalo, oryx and other antelopes, and, above all, of the reticulated giraffe are of very great interest; no one, with an experience wholly derived from Regent's Park, can imagine the grace of giraffes in free motion. The flashlight portraits of a lion and his mate also deserve special notice. Though perhaps less thrilling than some of the photographs of lions exhibited at other places recently, they are true to life, showing the animals as they normally behave, and not as they are when, infuriated by pain, they are held in a powerful trap, concealed by some convenient bush from the lens of the camera. Portions of the film will appeal also to those who are interested in anthropology, physical geography, and geology. Major Dugmore deserves success; and we hope that his lecture will draw large audiences for a long time to come.

The work that has been carried on by the British Science Guild since 1905, with the object of bringing about a better public appreciation of the value of science, is in many respects unique. There is no body that has done more to bridge the gap between the public and the man of science. Among various matters of general interest that are now engaging the attention of its various committees may be mentioned the adequate representation of science at the British Empire Exhibition and the question of a British Empire patent. The Catalogue of British Scientific and Technical Books has proved a valuable piece of work, and it is satisfactory to note that sales and contributions have brought in a sum which almost equals the cost of production. The publication of a new edition is now being taken in hand. An interesting step has been the issue of publicity leaflets summarising recent scientific developments in popular form. The first of the series, by Prof. J. C. McLennan, deals with "Helium and its Uses." The production in mass of this non-inflammable gas for use in airships is a fascinating story, and there is no more striking example of scientific achievement during the War. The second leaflet, by Prof. J. A. Fleming, on "The Thermionic Valve" is now in preparation. There is no doubt that this new departure will be of service in promoting the objects of the Guild. Naturally, however, such propaganda work cannot be conducted without the "sinews of war." At the special meeting at the Mansion House on February 27, and again at the annual dinner on May 30, reference was made to the appeal now being issued by the Guild for contributions to form a fund of 50,000*l.* to enable its programme to be energetically developed. It is to be hoped that this appeal, which has received most influential support, will meet with a generous response.

The second, or ladies', conversazione of the Royal Society this year will be held at Burlington House on Wednesday, June 20.

Dr. A. Bowman, senior naturalist on the staff of the Fishery Board for Scotland, has been appointed superintendent of scientific investigations under the Board.

Prof. C. Moureu, president of the Société Chimique de France, will deliver a lecture on "Les gaz rares des sources thermales, des grisous et autres gaz naturels" at the rooms of the Chemical Society, Burlington House, on Thursday, June 14, at 8.30 p.m.

H.R.H. THE PRINCE OF WALES has graciously accepted enrolment as an honorary member of the Institution of Mining Engineers and of the Institution of Mining and Metallurgy.

THE Board of Managers of the Royal Institution has elected Sir William Bragg to be Fullerian professor of chemistry, and director of the Laboratory and of the Davy Faraday Research Laboratory, in succession to Sir James Dewar.

THE list of honours conferred upon the occasion of the King's birthday includes the following names of men distinguished in scientific fields:—*Knights:* Mr. G. H. Knibbs, director of the Bureau of Science and Industry, Commonwealth of Australia; Prof. W. J. R. Simpson, professor of hygiene, King's College, London; and Dr. H. W. G. Mackenzie, senior censor, Royal College of Physicians. *Knight Companion of the Order of the Indian Empire* (*C.I.E.*), Mr. J. Evershed, director of the Kodaikanal and Madras Observatories. *Member of the Order of the British Empire* (*M.B.E.*), Mr. R. Ward, superintendent of the Botanic Gardens, British Guiana.

A limited number of fellowships for post-graduates in chemistry who are desirous of adopting an industrial career are being offered by the Salters' Institute of Industrial Chemistry to become operative in October next. The fellowships are of the annual value of from 250*l.* to 300*l.* each. Applications, with full particulars of training and experience, must reach the clerk of the Salters' Company, Salters' Hall, St. Swithin's Lane, E.C.4, before July 1.

UNDER the auspices of the Pontificia Accademia Romana dei Nuovi Lincei, a number of public lectures on subjects of scientific importance has been given recently in Rome. On April 26 and 27 Prof. C. J. de la Vallée Poussin, of the University of Louvain, lectured on functions of a real variable; on April 28, Prof. G. Gianfranceschi, of Rome, dealt with the structure of the atom; and on April 30, Prof. G. Boccardi, of the University of Turin, discussed the position of research on the variation of latitude. A lecture in commemoration of Louis Pasteur was delivered on May 2 by Prof. A. Anile, of the University of Naples, who dealt with the life and work of Pasteur. The addresses are to be printed and published by the Academy in due course.

THE Société Française de Physique, the headquarters of which are at 44 Rue de Rennes, Paris, was founded in 1873. There are now more than 1100 members, including 250 foreign members. Meetings are held twice monthly, and the transactions are published in a Bulletin. In addition to the Bulletin, members receive every month the *Journal de Physique et le Radium*, which publishes original communications, particularly on subjects dealt with at the meetings of the Society, and includes a review of a large number of French and foreign periodicals. Persons desirous of becoming members should send to the president a written application, supported by the recommendation of two members. The yearly subscription for foreign members is 65 francs, with an entrance fee of 10 francs.

IN connexion with the visit of H.R.H. the Prince of Wales to the East Hecla Works of Messrs. Hadfields, Ltd., to which reference was made last week, p. 759, we have received a description of the equipment of the works, including the research laboratories, which are provided with a very extensive range of instruments for the study and investigation of steels. In addition to the mechanical laboratories, in which alternating and impact tests are conducted as well as the older tests, there is a thorough equipment for the standardisation of pyrometers, whether thermo-electric, resistance, optical, or radiation. The apparatus in this section includes a Harker furnace for very high temperatures. Electrical and magnetic testing instruments are also included, in addition to the usual micrographic equipment. A feature of the department is the collection of specimens illustrating the researches which led to the discovery by Sir Robert Hadfield of manganese steel and of low hysteresis steel. Collections illustrating the early history of metallurgy were also exhibited on this occasion.

THE Board of Managers of the Washington Academy of Sciences has elected the following honorary foreign members in recognition of their prominence in their respective fields and their intimate connexion with scientific work in Washington: Prof. L. Manouvrier, Paris, for his work in anthropology; Dr. C. F. A. Christensen, director of Universitetets Botaniske Museum, Copenhagen, for his services to systematic botany, particularly his monographic studies of tropical American ferns of the tribe Dryopterideae; Dr. Paul Marchal, French Ministry of Agriculture, for his investigations in biological problems and their relation to agriculture, and especially for his research work in polyembryony; Mr. E. C. Andrews, Government geologist of New South Wales, for his work in geology, particularly in the fields of origin of coral reefs, physiography, origin of the Australian flora, mountain formation, and origin of metalliferous deposits; Sir Ernest Rutherford, for his distinguished work in chemistry; Prof. F. Omori, professor of seismology, Imperial University, Tokyo, for his outstanding work in seismology; Prof. G. Stefanini, Florence, for his investigations in palæontology and stratigraphy, especially the tertiary formations of Italy and echinoids in general; and Prof. Max Weber, University of Amsterdam, for his work in zoology.

IN the Journal of the Franklin Institute for May, General Squier describes a method of transmitting the telegraph alphabet which can be applied to radio communication, telegraph lines, and submarine cables. Owing to the rapid expansion of radio telephony and telegraphy the problem of interference, both natural and artificial, has become one the solution of which must shortly become imperative. As there are only a limited number of lanes through the ether their conservation is of international importance. Radio waves are used very widely in navigation and for radio beacons. In addition, we seem to be on the threshold of another great development—"photo-broadcasting," which will require and demand still more ether channels to serve the public of the near future. Radio telegraphy as conducted at present causes great disturbance. The power stations produce great explosions in the ether, the waves sent out having a wide range of frequencies which interfere with all forms of radio receiver. At present the radio engineer has utilised all the audio range of frequencies and several octaves of the radio frequency range. General Squier's plan is to utilise the infra audio range of frequencies, which are not used at present. An advantage of his system is that it cannot interfere with radio receiving. When applied to submarine telegraphy a modulating frequency of 10 per second corresponds to 75 words per minute, which is far higher than any form of sound reception.

AT a meeting of the Optical Society held on Thursday, May 24, Mr. R. S. Whipple, vice-president, in the chair, the sixth of the series of lectures on the evolution and development of optical instruments was delivered by Mr. David Baxandall, the subject being "Telescopes before the early part of the 19th century." The period from the time of Roger Bacon (d. 1292) to the beginning of the 17th century was dealt with at some length, particular attention being directed to William Bourne's description (1585) of a 12-inch perspective glass of about 15 feet focal length, which gave telescopic vision and magnified distant objects about twenty times. The invention of the telescope with concave eyelens by Hans Lippershey in 1608 was then dealt with and William Gascoigne's description of the way he arrived at the invention of telescopic sights quoted. The invention of the Gregorian and Newtonian reflecting telescopes was next referred to, and followed by a description of Hadley's reflector. The work of Chester Moor Hall, and the researches and work of John Dollond and Peter Dollond on the development of the achromatic lens, were also discussed. The lecture was illustrated by a number of pictures of old telescopes and by exhibits from the Science Museum, which included an early Italian telescope, and object-glasses or telescopes by various telescope-makers from the latter part of the 17th until the early part of the 19th century; the original glass negative made by Sir John Herschel in 1839; William Herschel's polishing machine, and the 7-foot reflector with which he discovered the planet Uranus. A number of these examples are from Mr. Thomas H. Court's collection in the Science Museum.

CAPT. R. AMUNDSEN hopes to undertake his projected flight across the North Pole about the end of June. After a visit to Nome, Capt. Amundsen returned to Wainwright, his winter quarters near Cape Barrow, the most northerly point of Alaska, in April last. The Norwegian Storthing has voted 60,000 kroner for an expedition to go to his support on the European side of the polar basin. In an article in the *Times* Mr. H. W. Sverdrup, second in command of the *Maud*, discusses the prospects of a successful flight to Spitsbergen or Cape Columbia in Grant Land. Capt. Amundsen has been provided by the United States Coast and Geodetic Survey with a Fischer sextant with an artificial horizon. This should allow him to measure the altitude of the sun with an exactness of 10′ to 20′ and possibly 1′ to 2′. If, however, the sun is obscured, Capt. Amundsen will require to fly by compass only. In this case he will have to change his course every now and then in order to follow a meridian from Point Barrow to the Pole, whereas from the Pole a constant course can be kept. If solar observations are impossible, there is only the actual flying time on which to calculate the position. Sixteen hours from Point Barrow should take the airman to the Pole, from which a compass course of N. 171° W. should land him on Spitsbergen. The difficulty will be to estimate leeway, etc. A contrary wind of about 10 metres a second would allow the aeroplane to reach only lat. 85° N. after sixteen hours' flight, and a course of N. 171° W. from there would take it to the New Siberia Islands. Mr. Sverdrup agrees that the prospects for a successful flight to Cape Columbia must be considered more favourable.

AT the annual meeting of the Illuminating Engineering Society on May 24, the report of the Council contained a summary of much varied and useful work. A joint committee, on which the Society and educational bodies will be represented, is to be appointed to consider courses of instruction in illuminating engineering, and the preparation of a suitable textbook for the use of students. Dr. J. F. Crowley presented a paper on "The Use of Synchronously Intermittent Light in Industry," which was illustrated by some striking experiments. The development of the neon lamp, which can be completely extinguished and lighted at a high frequency, has revolutionised methods and led to important industrial developments. By the aid of an oscilloscope utilising such lamps fed by an alternating current of regulated frequency, the motions of a high-speed machine can be apparently slowed down until they are almost stationary. Thus the movements of the mechanism of a sewing machine, illuminated by the intermittent light of a neon lamp, can be followed with perfect ease and any small irregularities observed at leisure. The method has been applied to many problems involved in textile machinery, where exact and regular speed-regulation is of great importance; and in other cases it is possible to detect and observe such phenomena as undue play at bearings, effects with whirling shafts, etc., which are quite unrecognisable by ordinary steady light. Mr. P. R. Ord also demonstrated the use of the Nutting-Hilger spectrophotometer for the comparison of natural and artificial daylight, an apparatus which affords valuable information on the colour-revealing qualities of such lighting units. A number of curves were shown to illustrate the departure from normal daylight and the extent of the variations in the spectrum of daylight at different times in the day.

MANY optical instruments, in the construction of which prisms form an essential part, are grouped together in a new catalogue which has just been issued by Mr. John Browning, of 37 Southampton

Street, Strand, London, W.C.2. A wide range of direct-vision pocket spectroscopes, some with and some without comparison prisms and micrometer scales, is included, together with larger portable sizes fitted with collimators. Among the table spectrometers manufactured by the firm is one of an auto-collimating type in which the telescope has an object-glass of 1 in. diameter and 9 in. focal length. The circle is 5 in. in diameter with two verniers reading to 1′. Other instruments described are stereoscopes, prismatic compasses, prismatic field and opera glasses, and there is also included a short, light-weight telescope having a Porro prism erecting system and fitted with a revolving adapter carrying two eyepieces giving magnifications of 10 and 15 respectively; this should prove useful to the tourist or naturalist. Simple explanatory notes describing the construction, use, and adjustment of the various instruments increase the usefulness of the catalogue.

THE latest catalogue (No. 444) of Mr. F. Edwards, 83 High Street, Marylebone, W.1, is devoted to biography and history. It contains a short list of lives of men of science, reasonably priced.

A TRANSLATION, by Jessie Elliot Ritchie and Dr. J. Ritchie, of Prof. H. Boule's "Les Hommes Fossiles" is to be published shortly by Messrs. Oliver and Boyd, Edinburgh, under the title of "Fossil Men: Elements of Human Palæontology." The work has been brought up-to-date by the addition of notes by the author.

As many of the works on natural history published by the Trustees of the British Museum (Natural History) are out-of-print and difficult to obtain, a list of the volumes on sale by Messrs. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, should be of interest to many readers of NATURE. The catalogue, classified according to subjects, is New Series, No. 7. It can be had upon application to the publishers.

THE Cambridge University Press is to publish this summer, under the title of "The Domain of Natural Science," the Gifford Lectures delivered by Prof. E. W. Hobson in the University of Aberdeen in 1921 and 1922. The work is an attempt to settle the relation of "that complex of knowledge and ideas which is denoted by the term natural science" to religion and philosophy at the present day. To attain this object the author has examined the historical development, aims, and true characteristics of the various departments of natural science. Vol. xviii., Q–S, of the Royal Society of London Catalogue of Scientific Papers, Fourth Series, will be issued by the same house immediately.

Our Astronomical Column.

JUNE METEORIC DISPLAYS.—Mr. W. F. Denning writes: "Sometimes a fair number of meteors are to be seen during the short nights of June, and there are many radiants visible, but they are so feeble that unless the observer maintains long vigils he will not gather sufficient paths to indicate the places of radiation accurately.

"Some of the chief radiants at midsummer are:

$213°+53°$	$245°+64°$	$252°-13°$	$252°-23°$
$260°-12°$	$260°-22°$	$261°+5°$	$280°-13°$
$272°+68°$	$282°-24°$	$354°+40°$	$355°+77°$

Considering that the twilight is strong and persistent during the whole of the night and that therefore the conditions are not favourable, the meteors are often more in evidence than would have been expected. The nights of June are also so agreeable for outdoor work that this particular time of the year is an attractive one to the student of meteors. It is true that what may be termed the real opening of the meteoric season occurs at the middle of July, but June anticipates a few of the advantages of the former month in a minor degree.

"The Perseids possibly commence to display the vanguard of their coming host at the end of June, and this question needs further attention. A few meteors exhibiting all the characteristics of the Perseids have been recorded so early as June 25-26 and with conformable directions, but it is just possible that other showers may have been responsible. To ascertain the truth two observations at distant stations are required, and observers should make special efforts to obtain them during the last week in June and first week in July. If this endeavour were thoroughly carried out we should soon acquire the necessary evidence and discover the opening date of the great Perseid shower. It is by far the finest annual display exhibited in the heavens and lasts for a longer period than any other stream, for late Perseids are seen until about September 5 and 6, when the radiant is at $90°+57°$ on the N.E. boundaries of Auriga."

THE CORONA OF 1908 AND SOLAR PROMINENCES.—In the Memoirs of the Kodaikánal Observatory (vol. 1, Pt. ii. p. 67) Mr. Evershed referred to the corona of 1908 as affording a test of the relationship of prominences to coronal streamers, because the Kodaikánal photographs of prominences showed considerable activity over the sun's south polar region and an almost complete absence over the north pole. In Mon. Not. R.A.S. vol. 83, p. 153, he returns to this subject because, as he says, "the corona, as drawn by the late Mr. Wesley from photographs obtained at Flint Island by Mr. McClean, shows the opposite distribution as regards the coronal streamers, which are more conspicuous over the north polar region than over the south, and thus the test in this instance appears to fail, although from previous eclipses there seemed to be a close correspondence between the coronal streamers and the principal zones of prominence activity." Mr. Evershed was therefore led to re-examine the orientation of the Flint Island photographs in relation to his own prominence photographs and Dr. Campbell's published photographs of the corona. He has now come to the conclusion that the north and south points on Mr. Wesley's drawings should be interchanged.

Mr. Evershed concludes that "Dr. Campbell's orientation is correct and that the corona of 1908 is not an exceptional case, but, on the contrary, adds weight to the evidence previously found for a close relationship between prominences and coronal streamers as advocated by Major Lockyer in his recent and also his earlier paper."

Research Items.

STEATOPYGOUS FIGURES FOUND IN FRANCE.—Female figures with that remarkable conformation known as steatopygous have been found in southern Europe from time to time, and have been connected with the peculiar build of Bushmen-Hottentot women. A figure of this kind discovered at Lespugue, Haute-Garonne, is described by Dr. René de Saint-Périer in *L'Anthropologie*, vol. xxxii. No. 5-6, with a useful list of references to other figures of the same kind.

BALKAN EMBROIDERY PATTERNS.—In the May issue of *Man* Miss Edith Durham publishes a series of interesting embroidery patterns from the Balkan Peninsula. Those worked in cross-stitch are generally used by the Slav-speaking peoples, those in chain-stitch by the Albanians. Up till very recent days embroidery was used lavishly on the garments of both men and women. The superiority of the Albanian as a designer is marked in this series. He is the artist of the Balkans, and the curvilinear patterns run through the inlaid metal work and carving, which is now fast dying out. He is usually his own silversmith, and the rough ornaments which he makes are extraordinarily like those found at Glasinatz, which include little doves pierced to wear as amulets.

"SHEEP-TRACKS" ON GRASSY SLOPES.—Close-set grassy ridges running parallel along the surface of a bank are familiar in many countries, and almost everywhere the popular explanation of their presence is that they are due to the traffic of sheep. Hilmar Ødum, of the Danish Geological Survey, has recently made a study of their appearance and development in the Færöe Isles and in Denmark, and finally disposes of the myth of their zoological origin (*Danmarks geolog. Undersøg.*, Ræk. iv. Bd. 1). He finds that the formation of the ridges, which he names "terracettes," originates in a settling of the loose earth on an unstable slope into a position of greater stability. At first a series of horizontal cracks appears in the turf covering a steep slope, then the narrow turf section between two cracks sinks slightly, turning at the same time about a horizontal axis, so that its surface comes to rest at an inclination rather less steep than that of the slope as a whole. The ridges, once begun, increase in definiteness, owing to the filtering out by the grassy coating and final settling of soil particles washed down by rain. The whole process is of a superficial character and is entirely a geological phenomenon.

THE POPULATION OF INDIA.—In anticipation of the report on the Indian Census of 1921, Mr. J. T. Marten, Census Commissioner, gave an interesting review of the results in a lecture delivered before the Royal Society of Arts and published in the Society's Journal of April 6. The economical conditions of the country suffered naturally from the effects of the War, and the difficulties attending the enumeration were increased by the failure of discipline among the people resulting from political unrest. The most interesting departure on this occasion was the attempt to extend the census of industries, but the weakness of the Industrial Department has made the result somewhat disappointing. Mr. Marten remarks: "We have a population with very considerable natural capabilities of increase. That increase is checked by ignorance of and indifference to maternal and infant welfare, by occasional famines and by epidemics, such as malaria, plague, and influenza. We endeavour year by year to minimise the effect of these checks. What if our endeavour should be successful? Can India support a considerable increase of population in the future under any conditions that seem likely to arise? If not, which is to lead the way to economy, the birth-rate or the death-rate, and will the other follow? In this connexion we have made some tentative efforts to collect in some provinces, where circumstances seemed most suitable, on special schedules, some statistics of the size and sex constitution of families in different social strata, with a view to obtaining information as to the normal fertility of married couples. The attempt is beset with difficulties."

CHROMOSOMES IN MAN.—The number of chromosomes in man has long been uncertain. In 1914 von Winiwarter published the most trustworthy account, finding 47 chromosomes in male germ cells and inferring 48 in the female. Other investigators found 24, and at one time it appeared that this half number was characteristic of the negro. Dr. T. S. Painter (*Journ. Exptl. Zool.* vol. 37, p. 29) has recently published a paper which probably settles the matter. He finds 48 chromosomes in both the white man and the negro. The reports of 24 were probably due to clumping of the chromosome pairs before fixation. Dr. Painter finds that the 48 chromosomes include an X-Y pair of sex-chromosomes. The Y-chromosome is very small and was probably overlooked by von Winiwarter. Painter also finds giant spermatogonial cells with larger nuclei and twice as many chromosomes (approximately 96). The occurrence of giant spermatozoa has long been known. If they are functional then triploid individuals might arise, and it is pointed out that some of these with new combinations of sex-chromosomes might be intersexes or hermaphrodites, such as have been shown to occur in a similar way in Drosophila.

MINERAL CONSTITUTION OF SOIL-TYPES.—James Hendrick and George Newlands (*Journ. Agric. Science*, 1923, p. 1) have examined the mineral particles constituting the more sandy grades separated from the "fine earth" of a number of British soils, dealing with the material finer than 3 mm. in diameter. They find that the separation of different minerals is practically impossible for grades below the "fine sand" of English workers—that is, finer than 0·04 mm., a figure that should have been stated. The coarser grades, however, can be divided mechanically, magnetically, and microscopically, into an "orthoclase group," including all the felspars, a "quartz group," and a "ferrosilicate group." A number of minerals, such as zircon, garnet, and tourmaline, that are "accessory" in the parent rocks appear in "surprising amount" in the soils, owing to their resistance to abrasion and decay. A greater surprise is the constant record of granular hæmatite, side by side with scaly yellow limonite. The authors hope that such investigations may be of service as showing the reserve of bases present in the silicate particles. The fresh state, however, of many of the felspars suggests that the agriculturist has little to gain from the coarser grades, apart from their influence on soil-texture, unless, as is quite possible, chemical exchanges take place on the surfaces of the grains. It is well, indeed, that the study of adsorptive reactions should not be entirely restricted to the colloidal field.

LAND MOLLUSCA OF THE SOUTH-WESTERN UNITED STATES.—In the year 1905 Dr. H. A. Pilsbry published the first of a series of memoirs on the "Mollusca of the South-western States." Later instalments were mostly written in collaboration with J. H. Ferris, and now the eleventh part by these two well-known American malacologists has just come to hand (Proc. Acad. Nat. Sci. Philad., vol. lxxv.). It is as admirable both in descriptions and figures as its predecessors, and deals principally with those members of the Helix family that inhabit the desert lands of Arizona. The genus Sonorella dwells in colonies in the interstices of the screes and tumbled talus of the volcanic rocks forming the hills of that arid and sparsely inhabited region, seldom coming to the surface save in very wet weather. Their collection is therefore an arduous matter only to be undertaken by a properly equipped expedition. The prospective interest lies in the fact that each group of hills seems to have largely its own species, or variety of snail, and that when the whole area has been surveyed important deductions as to the physical geography of the past may be built up on the evidence of the distribution, past and present, of these molluscan forms.

DORSAL EYES OF THE SEA SLUG.—K. Hirasaka (*Annot. Zool. Japon.* x., Art. 17, Dec. 1922) gives an account of the dorsal eyes of the amphibious sea-slug *Onchidium verruculatum*, which occurs abundantly near the Marine Biological Station at Misaki. The dorsal surface of the slug bears numerous papillæ of varying size, some of which are provided with eyes, one to seven in number. In the posterior third of the body some of the papillæ are of large size and branched, forming the respiratory "gill-trees." Semper stated that the eyes decrease in number as the slug grows, and he put forward the view that the eyes were in course of degeneration; but the present author shows that Semper was mistaken in his belief that the eyes disappear as growth proceeds. The cornea of each eye consists of modified epidermal cells, below which is a fibrillar connective tissue forming a circular sheet containing in its peripheral parts circular and radial muscle fibres. The lens is composed of a large distal cell and a small proximal group of cells, the former differentiated into a distal, spherical, more or less homogeneous body, and a basal cup-shaped part containing the nucleus. Early in development this cell exhibits a nerve issuing from its base, but the nerve becomes atrophied in the fully developed eye. The proximal lens cells form a group of usually three or four nucleated cells. Lining the proximal two-thirds of the pigmented cup which envelops the eye is the retina—a single layer of cells loosely packed together, and imbedded in connective tissue. In the basal part of each cell is a large lumen filled with a coagulable substance, and proximally the cell tapers into a nerve fibre which enters one of the nerves passing to the pleural ganglia.

MINERAL FERTILISERS.—As a result of three years' residence on the island, Launcelot Owen (Quart. Journ. Geol. Soc., vol. lxxix. p. 1, 1923) describes the deposits of tricalcium phosphate that are exploited in Ocean Isl., a member of the Gilbert group. These have originated in guano, which gathered in the hollows of a "karrenfeld," worn out of upraised coral-limestone. The fantastic features of this old surface of erosion have been well illustrated by G. S. Robertson in his work on "Basic Slags and Rock Phosphates" (1922), where views of the similar surface of Nauru Isl. are also given. L. Owen states that the loose friable phosphate is in no sense alluvial, but results from the aggregation of concretions. The coral-rock, including the pinnacles, became dolomitised, and was then permeated by the phosphate down to a depth of fully fifty feet. A level exists where the percentage of tricalcium phosphate sinks from its normal 88 to 79 per cent., and below this no phosphate deposits of any extent are found. The author (p. 13) rejects the idea of the occurrence of compounds such as dahllite and apatite, and is apparently unaware that the rock of Sombrero, once regarded as pure tricalcium phosphate, is now proved to consist of dahllite. He notes (p. 6) the occurrence of a translucent isotropic and amorphous phosphate, which he regards as colloidal. This is possibly the substance for which A. F. Rogers revived the name collophane in 1922. As a contribution to our knowledge of potassic fertilisers, the U.S. Geological Survey (Bull. 727, 1922) has published G. R. Mansfield's investigation of "Potash in the Greensands of New Jersey," with maps showing the distribution of the sands and marls. The general characters of glauconite as a fertiliser are now well known; its application to the land is beneficial, though it may not equal in effect the recently described "potash shales" of Illinois (Illinois Univ. Agric. Station, Bull. 232, 1921.)

SYNTHETIC MARBLE.—The generally accepted theory of the igneous formation of marble rests on crude experiments made by Hall (1801–3), in which chalk was heated in a closed gun-barrel. In the April number of the Journal of the Chemical Society Dr. M. Copisarow describes some interesting experiments, which tend to support an aqueous origin of marble. When solid calcium chloride and hydrated sodium carbonate, or a paste of precipitated chalk and sodium chloride solution were heated in an autoclave at 300° at a pressure of 24 atmospheres for 8 hours, a compact mass of marble, capable of taking a high polish, was formed. The salts present facilitated the solution of the chalk or other form of calcium carbonate and the high pressure conditioned crystallisation. When sodium sulphate was used with calcium chloride a compact mass of alabaster was formed.

SEA-LEVEL CHANGES IN DENMARK.—An investigation of a submerged peat-bog in the harbour of Rungsted, Denmark, by Dr. Knud Jessen, of the Danish Geological Survey, has revealed considerable changes in relative levels of sea and land in the neighbourhood of Copenhagen during the late-glacial period (*Danmarks geolog. Undersøg.* Ræk. iv. Bd. 1). About 260 metres off the coast, and at a depth beneath the surface of the sea of some 20 metres, was found a fresh-water clay—"Dryas-clay"—containing land plants, and this was overlaid first by deposits containing, among other things, bones of a vole and of a wild pig; secondly, by peat containing oak, alder, hazel, etc.; and, finally, by sea-mud with cockle shells and recent sea-sand. The indications seem to be that, at the beginning of the late-glacial period, the sea was 18 metres higher at Copenhagen than now, and that elevation of the land took place later, so that at the end of the late-glacial period it stood at least 24 metres above its present level relative to the sea; this elevation persisted from the younger Dryas-period till the Littorina submergence, which finally broke the land-connexion between Seeland and Scania.

VERTICAL MOVEMENTS OF THE ATMOSPHERE.—Mr. I. I. Kassatkine, in his monograph of the above title which has been published in the Bulletin of the Imperial Society of Naturalists in Moscow, 1915, puts forward a theory of rain formation. According to this theory, upward currents of air, on reaching the cloud level, cause still further separation of moisture by raising the clouds. The drops thereupon coalesce to form larger ones, which will eventually attain a size such that they can fall against the direction of the upward current, instead of being carried up still higher. Whether these drops reach the earth's surface or not will depend on the nature of the layers of air through which they must pass. If the latter are dry, and the upward current strong, they will have evaporated away before reaching the earth. If the height of the clouds is h_s, and the height to which they are lifted is h_b, then, before any rain can reach the earth, the ratio h_s/h_b must attain a limiting value a, which for Moscow has a value which varies from 2·5 to 3·5; when its value falls below this, irrespective of the degree of cloudiness, no rain can fall. The anomalously low rainfall of Swakopmund is explained, on this basis, to be due to the presence of a pronounced inversion caused by the sea-breeze, below the average cloud level, which inhibits the development of upward currents. Farther inland, where this factor does not exist, the rainfall is much greater.

PROJECTION FOR AERONAUTICAL MAPS.—In 1919 the International Aeronautical Conference decided to adopt the Mercator projection for the general small-scale air map. In the Geophysical Supplement (vol. i. No. 3) of the Monthly Notices of the Royal Astronomical Society, Col. E. M. Jack and Capt. G. T. McCaw contribute a paper on the value of Mercator in this connexion, answering criticisms that have been made regarding its adoption. The substance of the paper was read to the British Association at Hull. The essential value of these small-scale maps is for aerial navigation; that is, for the direction of the course of the aeroplane from one point to another. In consequence it applies not to local large-scale maps but to maps on a scale of 1 : 2,000,000 or 1 : 3,000,000. In most criticisms of Mercator, the use of the polyconic has been advocated. The authors reply to these arguments by pointing out that the disadvantages of the polyconic are threefold—the sheets do not fit together, the measurement of bearings is less simple and direct than in Mercator, and, with a single exception, no straight line represents anything in Nature save as an approximation. On the other hand, a good case is made for the use of Mercator, even if that projection, in common with all others, has some obvious defects. The authors answer the criticisms at length, but point to the essential quality that Mercator possesses, of representing a line of constant bearing as a straight line, as being of prime importance to the navigator. The varying scale does not trouble the aviator, but the bearing line enters into almost every problem with which he has to deal. Mercator enables him to solve these problems by simple graphic means, and, as a result, he prefers it to any other projection. At the same time the authors admit that, if flying beyond lat. 70° becomes common, some other projection will need to be used for polar regions, but this does not affect the problem at present.

FREE-AIR PRESSURE MAPS FOR THE UNITED STATES.—Supplement No. 21 to the U.S. *Monthly Weather Review* is a discussion on "the preparation and significance of free-air pressure maps for the central and eastern United States," by Mr. C. Le Roy Meisinger. The aim of the author is to develop barometric maps of free-air levels which shall have a direct and important bearing upon accurate forecasting for aviation. The discussion opens with "the history and problems of American barometry," and an explanation is given of the relations involved in the reduction of pressure from one level to another, temperature introducing a considerable difficulty. The author, referring to practical experience being required to demonstrate the value of free-air pressure maps, and stating that the United States does not possess this experience, mentions that in Japan daily maps of the 3-kilometre level have been drawn for several years and are of great service to Japanese forecasters. Details are given of Dr. R. Sekiguchi's experience in forecasting from these maps in Japan. Cyclonic centres in the Far East show better agreement with the trend of the isobars on the 3-kilometre maps than with that at sea-level. Various interesting examples are given, and probably valuable information may be gained from these for other parts of the globe. A large number of specimen maps are shown for sea level, 1-kilometre level, and 2-kilometre level, while details are given of each series. The work is of considerable importance to aviation, and the upper-air charts show what the winds are doing aloft when it is often impossible to gain the information from the sea-level charts. It is claimed that the discussion affords a glimpse of the physical processes at work, and may help to lift us from empiricism a little nearer to that ultimate goal toward which students of weather forecasting are striving.

ENDURANCE LIMIT OF STEELS. — Engineering Bulletin No. 136 of the University of Illinois contains an account of further experiments on the fatigue of metals, conducted by H. F. Moore and T. M. Jasper. The new results, which have been obtained by similar methods to those described in a former Bulletin, confirm the existence of a true endurance limit for steels of different compositions. For moderately hard steels, this limit may be found by rapid tests in which the rise of temperature is measured. Only a few preliminary tests have been made by Gough's method of determining the increase of deflexion as the range of stress is increased. A fairly close correlation is found to exist between the endurance limit and the ultimate tensile strength or the Brinell hardness, and a much less close connexion between the endurance limit and the yield point and limit of proportionality, there being no correlation with the impact or repeated impact values. It should be remarked, however, that the range of materials studied was not very wide, and the authors did not examine defective materials. A formula for the effects of cycles of stress not involving complete reversal is proposed, the results not being in agreement with Goodman's diagram.

A NEW FILAMENT ELECTROMETER.—In the issue of the *Physikalische Zeitschrift* for April 15, Dr. C. W. Lutz, of the Geophysics Observatory, Munich, describes an improved form of filament electrometer, which has been constructed by the firm of Edelmann, for use in the observatory. The filament is of platinum, and its lower part is attached to one end of a diameter of a circular loop of quartz fibre; the other end of the diameter of the loop being attached to the sliding frame by means of which the whole may be removed from the instrument for replacement of the filament. The deflectors between which the filament is placed are adjustable by means of screw heads outside the metal cover of the instrument. The filament is observed through a microscope magnifying 285 times, and, for distances of the deflectors from the filament exceeding 4 mm., the deflexions are proportional to the applied volts over the whole of the scale of the ocular of the microscope, which is graduated from a central zero to 50 on each side. The insulation throughout is amber. The sensitivity of the instrument may be varied by the usual methods from 0·001 to 2 volts per division of the scale.

The Royal Observatory, Greenwich.

ANNUAL VISITATION.

THE visitation of the Royal Observatory took place on Saturday afternoon, June 2. In addition to members of the Board of Visitors a large number of guests interested in astronomy were present, and took part in the inspection of the observatory and instruments.

The astrographic equatorial has been remounted on its return from Christmas Island, and the instruments left in Russia in 1914 have just arrived safely after an absence of nearly nine years. The Astronomer Royal in his report expresses his regret at the failure of the Christmas Island expedition; he notes, however, that the close verification of the Einstein shift by the Lick Observatory expedition renders it unnecessary to send an expedition from Greenwich to observe the Californian eclipse next September.

The exchange of wireless signals has reopened the question of the small differences of time-determinations at different observatories. Examination of the bearings of the transit circle showed that the western pivot was bearing only on its eastern edge; this was remedied by a slight lowering of the bearing. The test was made by placing some rouge on the bearings, then lowering and rotating the instrument; the presence or absence of rouge on the pivot showed where it was in contact with the bearing.

The results of the wireless time comparisons for the year are given; the annual means are Paris +0·10 sec.; Bordeaux +0·14 sec.; Nauen 0·00 sec.; Annapolis (August to December only) +0·03 sec. The plus sign means that the other station is late on Greenwich. In the case of Annapolis, the discordance is wholly explicable by the time of transmission; 0·06 sec. of the Paris and Bordeaux discordances is due to the fact that Leverrier's Tables of the Sun, used in France, differ by this amount from those of Newcomb. In the long run these differences will probably give excellent determinations of longitude.

Observations of the moon are dealt with in special detail in the present report, on account of the fact that Hansen's tables, used in the "Nautical Almanac" from 1862 to the end of 1922, have now been superseded by those of Brown. This was, therefore, selected as a suitable occasion for collecting all the Greenwich observations of the moon made since the time of Bradley, and reducing them to Brown's system (modified by using Fotheringham's secular acceleration, which is 4·79″ in excess of Brown's). It was then found that the residuals could be represented by two empirical terms, one with amplitude 3″ and period 70 years, the other with amplitude $1\frac{1}{2}''$ and period 59 years. The two terms are now in unison, producing a large oscillation, but in Bradley's time they tended to neutralise each other. A full comparison is given between Brown's Tables and observation for the first quarter of 1923; there is a nearly constant error in longitude of −7·8″, about half of which is due to Brown's use of too small an acceleration.

Observations with the Cookson floating telescope, lent by Cambridge Observatory, are being continued. Mr. Jones has revised his determinations of latitude variation with this instrument; and they are in satisfactory accord with those made elsewhere. One of the seven-year maxima of latitude variation is due about 1923. The 28-inch equatorial is being used for observation of close and difficult pairs; 66 pairs with separation less than 0·5″, and 105 between 0·5″ and 1·0″ have been observed during the year. Mr. Jackson is continuing to deduce hypothetical parallaxes for these and other stars.

The 26-inch refractor is being used for photographic determinations of stellar parallax; 49 parallaxes have been determined during the year, making a total of 195 with the instrument. The 30-inch reflector is being used for photography of stellar spectra with a combination of prism and grating. A principal spectrum is thus obtained, bordered by diffraction spectra of known relative intensities, thus determining the density gradient of the plate for all wave-lengths. With the astrographic equatorial some of the fields photographed about twenty years ago are being re-photographed through the glass, so that superposition on the earlier plates, film to film, enables proper motions to be deduced. The work has begun with zone 65° N. Declination, and will gradually approach the pole.

Sunspot activity continues to decline. There was, however, a considerable group of spots visible from December 22 until January 4 in latitude 6° N. A high-latitude spot in 41° S. was photographed on November 14 and 15.

The following are the provisional magnetic elements deduced for 1922:

Declination 13° 46·6′ W., Dip 66° 51·9′, Hor. Force 0·18449, Vert. Force 0·43181 (the last two being in C.G.S. units).

The weather report is for the twelve months ending April 30, 1923. The mean temperature was 49·8° F., being 0·2° above the average. On two days, both in May, the temperature reached 90° F. It fell to freezing-point on 21 days. There were 1404 hours of bright sunshine, 31·5 per cent. of the possible amount.

The Astronomer Royal naturally refers to the severe loss which the Observatory has sustained in the death of Mr. W. W. Bryant, noting his enthusiasm in former years as a meridian and double-star observer, and the zeal and energy with which he afterwards carried on the work of the Magnetic and Meteorological Department. Allusion is also made to the astronomers who have visited the observatory for special purposes during the year; they include Mr. Dodwell, director of Adelaide Observatory, Messrs. Comrie and Greaves from Cambridge, and Mr. S. Gaythorpe, who came to study the Horrocks MSS. in connexion with a biography of Horrocks which he is preparing.

A. C. D. C.

Royal Visit to University College and Hospital, London.

ON Thursday, May 31, the King, who was accompanied by the Queen, opened the new Institute of Anatomy at University College, London, and laid the foundation-stone of the new Obstetric Hospital. Her Majesty laid the foundation-stone of a Nurses' Home which is to be erected on an adjacent site in connexion with University College Hospital.

Before a gathering as brilliantly representative of the science and practice of medicine as of philanthropy and affairs, his Majesty said there could be but few instances on record in which any foundation had received 1,200,000*l*. from a single benefactor in a single gift. The magnificent generosity of the Rockefeller Trustees is the more impressive since it was bestowed by a citizen of the United States of America upon a college and hospital in London, and thus upon the people of Great Britain and the Empire. The declared purpose of the trustees is "to promote the well-being of mankind throughout the world." That they should have selected the University of

London to receive this princely endowment is not merely a high and well-deserved compliment and the creation of yet another tie of sympathy and friendship linking us to the United States; but it is also the evidence and declaration of their conviction that the progress of science and the welfare of mankind are not delimited by national or racial boundaries, and that work done in London for the relief of human suffering, the improvement of medical education and the advance of science, is a service to the whole world. The advance of knowledge and the ever-rising standard of medical education necessitate reorganisation which would give an impetus to the more effective training and equipment of the British practitioner. The underlying principle is as old as Ecclesiasticus: "The wisdom of a learned man cometh by opportunity of leisure, and he that hath little business shall become wise." Its specific application to medical teaching and research is new.

Continuing, the King referred to her Majesty's particular satisfaction on learning that the care of maternity and infant life, in which the Queen has always been actively interested, is part of the scheme, and that the claims of the nursing service have not been overlooked. The privilege of accepting the munificent gift of the Rockefeller Trustees imposes obligations upon the staff to fulfil the ideals which it represented, and upon the public to furnish necessary support. It is inconceivable that Englishmen should decline to welcome this generous challenge from our kinsmen across the Atlantic to a friendly rivalry in medical skill, devotion, and beneficence. His Majesty cordially wished Godspeed to this great enterprise.

The address was followed with responsive attention, and when the stones were laid their Majesties proceeded to the library of the Medical School and thence to the new building of the Institute of Anatomy. A tour of the building was made, their Majesties being particularly interested in the brilliantly-lighted dissecting-room and the equipment of the X-ray rooms, where the director of the Institute, Prof. G. Elliot Smith, demonstrated various radiographic and anatomical exhibits, among them plates taken twenty years ago of the mummy Thothmes IV., and whole specimens made transparent by the Spalteholz method to facilitate comparison with X-ray plates by students of anatomy. Both their Majesties were also keenly interested in radiographic plates and photographs shown by Mr. H. A. Harris revealing the effect of successive illnesses upon the growth of the long bones of a child.

The Mind of the Maori.

THE authorities of the Dominion Museum at Wellington, New Zealand, have published a series of monographs on the ancient institutions, mental and spiritual concepts, and ceremonies of the pre-European Maori, with an examination of the esoteric meaning underlying innumerable personifications and mytho-poetic allegories. They are written by Mr. Elsdon Best, who is regarded as the greatest living authority on Maori history and folklore.

In the first paper mentioned below,[1] stress is laid upon the two different phases of Maori religion. The ritual and teaching of the priests and men of superior rank were of a distinctly higher type than that of the common people. They formed the most intensely *tapu* portion of Maori esoteric lore and were so jealously guarded that for many years they were entirely unknown to Europeans.

Mr. Best's account of Maori myths is derived from the East Coast tribes. There is an elaborate cosmogony. Things celestial and terrestrial are spoken of as persons, and the processes of evolution are described in genealogical form. In the beginning was the vast unknown time of Po, before Rangi and Papa (sky and earth) appeared. From the union of these arose certain supernatural beings whose names are known throughout Polynesia—Tane, Tu, Rongo, Tangaroa, Tawhirimatea, and Whiro. These beings formed and arranged the present world. Mr. Best gives a highly poetical account of their varied exploits, and in some of the concepts finds a likeness to ancient beliefs in Chaldea, Egypt, India, China, and Japan. The cosmogonic genealogy of Rangi and Papa, which in one account consists of such names as Pu (root), More (extremity), Take (stump), Weu (fibre), is compared to the World-Tree of Scandinavian myth, and the three baskets of knowledge obtained from the heavens by Tane are likened to the three baskets or books of knowledge of the Indian Buddhists.

Mr. Best describes four classes of Maori gods. The first, alone, is Io, the supreme deity, then come the departmental and tribal gods, and lastly, the spirits of dead ancestors. The startling suggestion is made that the name Io may be a form of Jehovah. Several other gods are compared with those of Egypt and Assyria.

The Maori conception of the spiritual nature of man is concisely stated by Mr. Best in the following account from a native: "The conclusions he arrived at from what he considered clear evidence were—that man possesses a spiritual quality that leaves the body during dreams and quits it for ever at the death of the physical basis (this is the *wairua*); that death is marked by the passing, the extinction, of an invisible activity called the *manawa ora* (breath of life); that man also possesses a physical life-principle termed the *mauri*—one that cannot desert the living body but does so at death; that he possesses yet another life-principle called the *hau*, that can be affected by the arts of black magic; that man possesses several sources of mental and intellectual activity, and that the semblance of man, or of any entity, may be taken and employed as a medium in ceremonies believed to affect the originals."

The papers on astronomical knowledge and the division of time are remarkable examples of Mr. Best's intimate acquaintance with the lore of the Maori people. The Maori named the heavenly bodies and accounted for them in myths; they used them as time measurers and guides in navigation; and they personified them and worshipped them as benefactors and deities.

In these papers Mr. Best has given us a highly interesting and in many places an intensely poetical account of the speculations and fancies of the Maori mind. The only weak points are the comparisons of Polynesian names with those of the ancient world. These entirely fail when the words are traced by strict phonetic law to their cognates in Indonesia and Melanesia.

SIDNEY H. RAY.

[1] Dominion Museum Monographs. No. 1. Some Aspects of Maori Myth and Religion. No. 2. Spiritual and Mental Concepts of the Maori. No. 3. The Astronomical Knowledge of the Maori, Genuine and Empirical: including Data concerning their Systems of Astrogeny, Astrolatry, and Natural Astrology, with Notes on certain other Natural Phenomena. No. 4. The Maori Division of Time. By Elsdon Best. Wellington (New Zealand), 1922.

The Promotion of Research in the University of Bristol.

IT is common knowledge that the universities of Great Britain are woefully lacking in funds specifically allocated to the furtherance of their main function, namely, research. Too much prominence cannot, therefore, be given to the activities of the Colston Research Society in the city of Bristol, the object of which is the promotion of research in its University. This Society, under a slightly different name, was originally founded in 1899 for the purpose of promoting the cause of a university at Bristol, and it played a most influential part in securing the foundation of the University ten years later. It then turned its attention to the assistance of a specific branch of university activity and chose that of the promotion of research.

The Society met for its annual dinner and collection on June 1 under the presidency of Mr. Claude B. Fry, with Prof. Flinders Petrie and Sir Richard Gregory as the principal guests. The collection, which amounted to 669*l*., brought the total sum collected since its inauguration twenty-three years ago up to nearly 12,000*l*.

The annual sum of about 600*l*., which is thus available for research, is allocated to the various departments of the University of Bristol by a joint committee of the Society and the University. It is interesting to note that, while the greater part of the funds collected is provided by local merchants and industrial firms, the Society accepts the term research in its widest sense and has recently made awards to the arts faculty, which will be continued so far as funds permit.

In addition to the collection, an important extension in the activities of the Society was made by the president for last year, Mr. Ernest Walls, which seems likely more and more as years go on to cement the relationship between the University and local industries. This act was the foundation of a number of annual Colston research fellowships. These fellowships are post-graduate in character and are earmarked to a particular faculty or branch of research, or to a particular research problem. In those cases in which the research problem is of an industrial character and carried out, with the consent of the supervising professor, at the wish of the firm, additional funds for apparatus and material are also available. The donor of a fellowship has access to the research work and receives the results of the work twelve months prior to publication. During last year fellowships were provided by the Imperial Tobacco Co. (botany), Messrs. J. S. Fry and Sons (engineering), Christopher Thomas Bros. (chemistry), Messrs. Packer and Sons (chemistry), Mr. Frank Cowlin (medicine), and Messrs. E. S. and A. Robinson (chemistry). That the scheme is an undoubted success is borne out by the fact that at the recent meeting of the Society it was stated that five of the above fellowships were being renewed for a second year and that two new fellowships had been promised, one from Messrs. Carsons, Ltd., and the other from Messrs. William Butler, both in chemistry.

To those conversant with the relations between universities and industry in a country like the United States, this may seem to be a very small organisation; but in the present depressed state of the finances of British universities, the existence of one Society rallying to the support of the most essential function of a university is exceedingly encouraging, and the scheme may be commended to the notice of other centres of learning.

Radiation Theory.

ON Monday, May 28, a lecture was delivered at the University of Edinburgh by Prof. H. A. Lorentz, of the University of Haarlem, on "Primary and Secondary Radiation." In the course of his remarks, Prof. Lorentz said that in former times the radiation of light was held to be due to the presence in the luminous source of small particles vibrating about positions of equilibrium; in the electromagnetic theory of light this idea became more definite, in that the oscillating particles were supposed to be electrically charged. The progress made in the last few years has shown that, in many cases at least, this explanation of radiation can no longer be maintained.

In Bohr's theory of spectral lines, the emission of light is due to the transition from one stationary state of an atom to another. The frequency of the emitted radiation is determined by the change in the energy of the atom, and is widely different from the frequency really existing in the atom, in which the electrons freely revolve around the nucleus. When light is emitted by a luminous body, and, in general, when we are concerned with the original production of waves, we can speak of a *primary* radiation, whereas the term *secondary* radiation can be applied to those cases in which particles that are struck by incident rays thereby become centres of emission.

There is perhaps but one case of primary radiation for which the old theory still holds, namely, the emission of electromagnetic waves by an antenna. If, as has been shown by the experiments of Tolman and Stewart, an electric current in a metallic wire consists of a motion of electrons, then this must also be true of the alternating currents in the antenna, so that here the oscillatory motion of the electrons is seen to produce waves.

As to the secondary radiation, this appears in many cases to conform to the classical laws. This can be illustrated by the consideration of (1) Huygens' principle and his construction for the progression of a wave front, (2) the propagation of light in a system of molecules, (3) the scattering of light by molecules (blue of the sky, Lord Rayleigh's formula), (4) the scattering of X-rays (Barkla's experiments), (5) the diffraction of X-rays by crystals, it being possible, as has been shown by W. L. Bragg and Bosanquet, to calculate in this case the intensity of the secondary beams by means of the old theory.

Even for the primary radiation of light, the classical theories need not wholly be abandoned.

Soil Acidity and Plant Distribution.

AN important series of studies on the hydrogen ion concentration of the soil and its relation to plant distribution has been published by Carsten Olsen (*Compt. rend. Lab. Carlsberg*, xv., 1923). These studies deal with the hydrogen ion concentrations of a series of Danish soils covered by natural vegetation, the observed range being from P_H 3·4 to 8·0. The composition of the vegetation is found to be very closely correlated with the hydrogen ion concentration of the soil, and the author considers that the distribution of the more important species may be largely determined by this factor. The number and density of species in a given place are also found to be greatest when the soil reaction approaches neutrality. Olsen further points out that the vegetation of alkaline soils poor in mineral nutrients bears no resemblance to that of very acid soils poor in nutrients. This section of the paper is very impressive in its wealth of data, and it includes exhaustive tables showing vegetation composition in relation to P_H and also a large number of partial soil analyses. Only those who have used the field methods employed by Olsen can really appreciate the extent and thoroughness of his investigations.

The author then deals with the growth of typical indicator species in water cultures. Species normally growing on acid soils are found to show best growth in nutrient solutions with a reaction of about P_H 4·0. On the other hand, plants normally growing on neutral or alkaline soils show most vigorous growth in culture media of about P_H 6 to 7. In these media the plants of acid soils do not thrive and become chlorotic. Olsen further examines the theory of Hartwell and Pember that soil acidity may be associated with the toxicity of aluminium ions. Though aluminium was found to be toxic to barley, the theory appeared not to be valid for plants of alkaline soils in general. Further, while his observations confirm the idea that acid soils as a whole produce ammonia rather than nitrates, Olsen's experiments show no evidence for the supposition that the plants normally growing on acid soils utilise ammonia and not nitrates, or that the plants of alkaline soils can only utilise nitrates. Both nitrates and ammonia appear to have the same value as sources of nitrogen in the cases examined, and, moreover, nitrification may be much more active in acid soils than is commonly supposed, as rapid nitrification existed in soils as acid as P_H 4·4.

This valuable paper should be in the hands of all those interested in soil acidity and plant growth.

University and Educational Intelligence.

BIRMINGHAM.—The late Elizabeth Kenway of Moseley has left to the University a legacy of 1000*l.*, free of duty, to be applied as the Council shall think fit.

We learn from the *Times* that the late Joseph Samuel Taylor, of the firm of Taylor and Challen, engineers, has left the residue of his estate, after numerous bequests to local charities, to the University for research work in mechanical engineering, metallurgy, and chemistry.

CAMBRIDGE.—In connexion with the coming meeting of the International Union of Pure and Applied Chemistry, it is proposed to confer honorary degrees of Doctor of Science on M. A. Haller, president of the Academy of Sciences of the Institute of France, Prof. W. D. Bancroft, Cornell University, Prof. E. J. Cohen, University of Utrecht, Prof. C. Moureu, Collège de France, Prof. R. Nasini, University of Pisa, Prof. A. Pictet, University of Geneva, and Prof. F. Swarts, University of Ghent.

Mr. J. E. Littlewood, Trinity College, has been reappointed Cayley lecturer in mathematics; Mr. R. A. Herman, Trinity College, has been reappointed University lecturer in mathematics, and Mr. J. Gray, King's College, has been re-elected Balfour student.

It is recommended that a special grant of 25*l.* be made to the Marine Biological Station at Plymouth.

MANCHESTER.—The Sheridan Delépine research fellowship in preventive medicine, value 300*l.* for one year, will be awarded shortly. The elected candidate will be required to register as a research student of the University, and to devote the whole of his time to research in the department of bacteriology and preventive medicine. Applications, together with particulars of the qualifications of the candidates and of the proposed subject of research, should reach the Internal Registrar on or before June 15.

ST. ANDREWS.—The Court has agreed to hold in trust a sum raised in recognition of Dr. David McEwan's services as professor of surgery in Dundee. The income from the fund is to be employed in providing an annual prize in surgery to be awarded to the best student in that subject in the Final M.B., Ch.B. Examination in the University.

It is expected that Mr. Rudyard Kipling, Rector of the University, will be installed and will deliver his rectorial address on Tuesday, October 9.

THE summer meeting of the Association of Women Science Teachers will be held at Reading, on Saturday, July 7.

NOTICE is given that applications for the Ramsay Memorial fellowships in chemical science, of the value of 300*l.* a year each, must be made not later than June 15 to Dr. Walter Seton, secretary of the Ramsay Memorial Fellowships Trust, at University College, London, W.C.1, from whom full particulars of the conditions governing the award can be obtained.

APPLICATIONS are invited from Edinburgh University medical women for the Dr. Jessie Macgregor prize of 50*l.* for the best piece of original work, published or unpublished, in the science of medicine. Competitors must lodge the record of their work, accompanied by a letter vouching that the work was done by the sender, and mentioning the place or places in which it was carried out, not later than June 30, with the Convener of the Trustees, Royal College of Physicians, Edinburgh.

THE University of Geneva is organising a summer school in which are included two attractive courses of botanical and geological field-work. The botanical course, opening on July 10 and closing on September 10, will be conducted by Prof. R. Chodat, director of the Alpine station at Bourg-St. Pierre in the Grand St. Bernard region, where the course is to be held, and studies will be made of Alpine flora, plant distribution, etc. The geological course will be in the charge of Prof. L. W. Collet, professor of geology in the University of Geneva, and the first portion, July 10-15, will be spent at the University. The remainder of the course, July 16-August 10, will be devoted to field-work on tectonics and glacial geology. Both courses provide opportunities for numerous expeditions. Further information about the courses can be obtained from the Secretary of the University of Geneva, or in Great Britain, from the Economic Division, Swiss Legation, 32 Queen Anne Street, London, W.1.

A STUDY of Dental Education was undertaken early in 1921 on behalf of the Carnegie Foundation for the Advancement of Teaching by Dr. William J. Gies, of Columbia University. Each of the Dental Schools of the United States (47) and Canada (5) has been visited, its equipment thoroughly inspected, and its relationships with other educational institutions ascertained. The investigation has been carried on with the active co-operation of the Dental Educational Council of America and the Canadian Association of Dental Faculties and of the local faculties. The recently published annual report of the Carnegie Foundation announces that Dr. Gies's report will shortly be ready for issue. There being no national board of dental examiners, the examinations for licence to practise in the several States are dissimilar, and the dental laws differ in many of their requirements where uniformity would have obvious advantages. A compilation of these laws, which have not hitherto been easily accessible for comparative study, has been prepared and will shortly be issued with comments on their main educational features. Custom blinds us to the anomaly of the isolation of dentistry as compared with ophthalmology, aural surgery, laryngology, and other specialties of medicine —of putting teeth and jaws in an elaborately insulated compartment by themselves—and a reconsideration of fundamentals such as is likely to be involved in and entailed by Dr. Gies's study may have beneficial results.

Societies and Academies.

London.

Royal Society, May 31.—E. **Griffiths** and G. W. C. **Kaye**: The measurement of thermal conductivity, No. 1. Three types of apparatus of the "plate" type are described for the rapid precision determination of the thermal conductivities of materials at low conductivity. Energy was supplied by electrical means and temperatures were measured by thermocouples. An average time for the attainment of the "steady state" was 30 minutes or less, and the average accuracy of measurement of the conductivity was about 1 per cent. Among the topics discussed was the thermal resistance at the bounding faces of a material, the effect of superimposing layers of compressible material, the measurement of the thickness of compressible material, the dependence of the conductivity of timber on structure and moisture-content and the variation of the conductivity of rubber with mineral content.—G. W. C. **Kaye** and J. K. **Roberts**: The thermal conductivities of metal crystals. I.—Bismuth. A "plate" apparatus measuring thermal conductivities as high as 0·02 C.G.S. with an accuracy of about 1 per cent., using specimens 2 cms. by 1 cm. in area and about 1 or 2 mm. in thickness was used. The conductivities of single crystals of metallic bismuth in directions parallel and perpendicular to the trigonal axis at 18° C. are, in C.G.S. units, 0·0159 and 0·0221. The ratio of conductivities is 1·39. The mean value 0·0191 agrees well with the figure 0·0193 obtained on bars by Jaeger and Diesselhorst in 1899. Thus in the case of bismuth metal in the aggregate, the distribution of the constituent small crystals is random, and the effect on the thermal conductivity of any inter-crystalline layers is not appreciable.—C. V. **Drysdale** and S. **Butterworth**: The distribution of the magnetic field and return current round a submarine cable carrying alternating current. Pt. I. (By C. V. Drysdale.) An exact knowledge of the magnetic field distribution in the neighbourhood of a submarine cable is of great importance in connexion with leader gear and the propagation of radio signals between submerged stations. Investigations have been carried out since 1918 at the Admiralty Experimental Stations at Parkeston Quay and Shandon, with the object of determining the magnitude and phase of the magnetic field in and above the surface, and of the return current in the water, as well as the velocity of propagation and attenuation of the electro-magnetic waves in the water and the shielding effect of the cable armouring. Measurements were made with an alternating current potentiometer on horizontal and vertical search coils above and below the surface and on electrodes in the water at frequencies from 50 to 500 periods per second. Pt. II. (By S. Butterworth.) Expressions for the distribution of electric force due to a long cable carrying alternating currents and immersed in a sea of uniform depth have been obtained in the form of Fourier integrals and formulæ have been developed which cover the following cases: (1) The field above the surface of the sea when the depth of the water is small; (2) the field above the sea at large distances from the cable, there being no restriction in regard to depth; (3) the field below the surface of the sea for points vertically above the cable; and (4) the field below the surface of the sea at large distances from the cable when the depth of the sea is great. The results for points above the surface of the sea have been verified by tests in which the sea is replaced by a sheet of lead. The formulæ are in substantial agreement with actual sea observations.—S. **Russ**: The effect of X-rays of different wavelengths upon some animal tissues. Two regions in the X-ray spectrum were selected, and it was arranged that equal doses of X-ray energy were absorbed in their passage through the tissues. In these circumstances more profound effects were produced by the longer wave-lengths (0·45-0·30 Å.U.) than by the shorter wave-lengths (about 0·168 Å.U.), both upon the normal skin of the rat and upon Jensen's rat sarcoma. The degree of this differential action is more pronounced in the case of the skin than it is for the tumour, the numerical values being 6 and 2·6 respectively. These numbers are termed "therapeutic factors."—E. F. **Armstrong** and T. P. **Hilditch**: A study of catalytic actions at solid surfaces. Pt. XI.—The action of alumina and certain other oxides in promoting the activity of nickel catalyst. In the absence of any carrier for the nickel, the presence of a small proportion (up to 5 per cent.) of an oxide, such as that of aluminium or magnesium, increases the catalytic activity of the reduced metal. When the nickel oxide is deposited on a support, *e.g.* kieselguhr from which the metallic constituents have been extracted, the catalyst is inferior to that on natural kieselguhr. Its activity is restored if about 20 per cent. of alumina is precipitated with the hydroxide of the nickel. If this proportion of alumina is first deposited on the acid-extracted kieselguhr and the nickel hydroxide or carbonate then precipitated on to this preparation, the catalytic activity of the product generally exceeds that of nickel on the natural kieselguhr. It seems that the action of the non-reducible oxide is mainly mechanical and connected with increase or diminution of the surface area of the exposed nickel.—N. K. **Adam**: The structure of thin films. Pt. IV.—Benzene derivatives.—A condition of stability in monomolecular films. Derivatives of benzene, such as hexadecyl phenol, containing one long chain and one polar group in the para position, orient on water surfaces like fatty acids, the phenol group forming the head of the molecule in contact with the water. Compounds such as cetyl palmitate, palmitic anilide, etc., which contain one polar group placed between two chains or one chain and a ring, do not adhere to a water surface well enough to give measurable condensed films. The para sulphonic acids in hexadecyl and octadecyl benzene give soap-like solutions in water. Pt. V. Bromine in the α position, in the bromo-acids and esters, increases the cross-section of the molecules in the films. The bromine atom increases the solubility of films of the higher fatty acids. It also lowers the temperature of change from condensed to expanded films; but it does not appreciably affect the properties of the films, when expanded. The double linkage in the α β position relative to the $COOC_2H_5$ group increases the cross-section of the molecule in the films, as it does in iso-oleic acid.—W. B. **Rimmer**: The spectrum of ammonia. Of the three bands which are associated with the spectrum of ammonia, the ultra-violet band has already been investigated in detail by Fowler and Gregory, and is represented in the solar spectrum. The "Schuster bands" λ 5635 and λ 5670, have given no sign of resolution under high dispersion, and it is probable that they do not occur in the solar spectrum. The "α band" of Eder and Valenta is of great complexity, consisting of about 3000 lines; there is no conclusive evidence that this band occurs either in the solar spectrum or in the spectrum of sunspots. The Schuster bands seem to have their origin in the normal ammonia molecule and the ultra-violet band is probably due to emission from a more stable combination of nitrogen and hydrogen. The α band appears to be associated with a combination of nitrogen and hydrogen of intermediate stability. The occurrence of the ultra-violet band alone in the solar spectrum indicates that only the most stable combination of nitrogen and hydrogen can exist under the conditions that obtain in the reversing layer.

Royal Microscopical Society, May 16.—E. J. Sheppard, vice-president, in the chair.—W. M. **Ames**: Applications of the microscope in the manufacture of rubber. This work falls into two divisions, examination of pigments and examination of microsections of rubber, both of which involve special methods. For work on pigments, particularly when investigating particle size, slides should be prepared by the method of Green so as to ensure uniform distribution of the pigment in one plane. The microscope enables relative particle sizes to be determined with certainty. Owing to the great resiliency of rubber, the preparation of sections sufficiently thin to be examined by transmitted light is difficult. Inorganic pigments if present can be identified, and their distribution studied. Certain organic materials such as fibre, reclaimed rubber, glue, and rubber substitute can also be identified. The behaviour of the sulphur formations in the rubber can be observed as the rubber perishes, and a comparison made between natural and artificial (heat) ageing. The variation, with temperature, of the solubility of sulphur in vulcanised and unvulcanised rubber can also be observed. When rubber under strain is examined, vacua are found between the separate units of sulphur formations, and at the poles of crystalline pigments, but have not been detected in the case of gas-black or zinc oxide. Permanent internal deformation is visible in the rubber after retraction.

Geological Society, May 16.—Prof. W. W. Watts, vice-president, in the chair.—W. B. R. **King**: The Upper Ordovician rocks of the South-Western Berwyn Hills. The district described lies in the south-eastern corner of the 1-inch Ordnance Survey Map, Sheet 136 (Bala). The area is one where the beds strike in a north-easterly and south-westerly direction, with dips nearly vertical. The black graptolitic shale-group is of shallow-water, probably lagoon, origin. The area appears to have been one of shallow water throughout Upper Ordovician times, and actually became land at the end of that period. The gap in the succession occasioned by this uplift was greatest in the south-east, near Welshpool; while the areas on the north (Glyn Ceiriog) and west (Bala) remained under the sea. The shallowing of the water in these areas is, however, manifested by the deposition of either gritty beds or oolitic limestones. A new species of Calymene is described from the upper part of the Ashgillian, where it is taken as a local index-fossil.—W. J. **Pugh**: The geology of the district around Corris and Aberllefenni (Merioneth). The succession and structure of an area of about 25 square miles, lying south-east of Cader Idris, are described. The area has been surveyed on the scale of 6 inches to the mile. The rocks are partly Lower Silurian and partly Upper Ordovician in age. The Valentian succession is similar to that described at Machynlleth (O. T. Jones and W. J. Pugh, Q.J.G.S. vol. lxxi. (1915–16), p. 343), and the same classification is retained. It is considered to rest conformably upon the Bala series. The general strike, from south-west to north-east, is determined by the fact that the area lies on the south-eastern flank of the Harlech Dome; but the district is crossed by important folds transverse to the normal strike. These structures have been correlated with those described farther south at Machynlleth.

Aristotelian Society, May 28.—Prof. A. N. Whitehead, president, in the chair.—C. Delisle **Burns**: The contact of minds. The word "mind" is taken to mean mental process or percipient event, and thus to refer to all such facts as thinking, feeling, and the sensation which accompanies or is part of thinking. It is generally admitted that mental processes are grouped so that they "belong to" distinct persons or selves; but there is also a connexion between these groups of mental processes in co-operation or communication or intercourse between persons. In communication "I" am aware that "you" are thinking, that is to say, I am aware that you are or have a mind; or it may be said that I am aware that an "other" mind exists. The problem to be considered, then, is *how* I come to know that an other mind exists. The traditional view is that "I" come to know that other minds exist by a process of inference, based upon a comparison of my "body" with other bodies. This traditional view has already been attacked by Lossky and others. It seems false, first, because it implies a very unlikely description of psychological development. Secondly, at any stage in life the differences between my own body and other bodies in my contemplation are so great that the likeness can scarcely be a valid logical ground for the belief that other minds exist. As an alternative to the traditional view, therefore, it is suggested that Prof. Alexander's term "enjoyment" may provide an explanation of the way in which "other" minds come to be known. But enjoyment must then be taken *not* to imply any process peculiar to "my" thinking or feeling. That is to say, there must be enjoyment of co-operation or communication. As objects are given in contemplation, so other minds are given in another form of awareness. There is, then, direct contact of minds, not "through" bodies or across any bridge which is non-mental. This, however, does not mean that mind is not bodily; since mental process is probably the name for a relation, the terms of which are bodily. We need not assume that mental process is explicable in terms of "body" or that "body" is explicable in terms of mental process: but the contact of minds occurs in one area of reality and the contact of bodies in another, and the two are inseparable, as the force called gravitation is inseparable from "mass."

DUBLIN.

Royal Irish Academy, May 14.—Prof. Sydney Young, president, in the chair.—J. J. **Nolan** and J. **Enright**: Experiments on large ions in air. The effects of such substances as sulphur dioxide and ammonia on the development of large ions were investigated. The effect of temperature on the large ions was examined. The large ion is unaffected up to 100° C., but at that temperature begins to break up. The coefficient of recombination between large and small ions was determined. The conditions under which multiple charges on the large ion can occur were investigated. The large ion in the atmosphere has probably a single electronic charge.

EDINBURGH.

Royal Society, May 7.—Prof. F. O. Bower, president, in the chair.—Miss A. V. **Douglas**: The sizes of particles in certain pelagic deposits. Samples of sea bottom brought back by the *Quest* from the South Atlantic bottoms were examined for the distribution of sizes of particles. The estimation is made by allowing continuous deposit of the particles from suspension in water upon one pan of a balance and thence ascertaining the rate of deposit and estimating the associated sizes, employing Stokes's law. The result is a measure of relative numbers of particles of each equivalent spherical radius. Six samples are treated, three of diatomaceous ooze, and three of globigerina ooze. The features of the curves showing proportionate distribution of sizes confirm the characters formed by Sven Odén from the *Challenger* specimens.—R. A. **Houstoun** and W. H. **Manson**: Note on a new method of investigating colour blindness. In a previous paper Dr. Houstoun investigated 23 cases of congenital colour blindness and exhibited the results by contour lines on the colour triangle. The same method has been applied to 14 cases of colour blindness induced by disease. The results show that there is no difference in kind between the two classes of cases, and that here also trichromasy passes into monochromasy directly without passing through dichromasy as an intermediate case. W. **Peddie**: The mechanism behind relativity. The Lorentzian equations of transformation from one reference frame to another were introduced in order that Maxwell's equations of propagation of electromagnetic action should be invariant in form under the transformation. Besides this explicit assumption, there is, further, the implicit postulate of a single unique luminiferous ether through which action is propagated at a constant (or approximately constant) speed. The theory of relativity was originated by the latter postulate as much as by the former. The compulsion to adopt Lorentzian relativity disappears if we postulate instead that each atom of matter is associated with a strain form (in an underlying ether) through which alone it receives light, and that it emits light into the similar strain forms of other atoms. The Michelson-Morley result, the aberrational effect, the Fresnel dragging coefficient, and the Doppler effect, all follow; and only the Newtonian relativity is employed, for light is propagated independently to each observer.—R. A. **Sampson**: On Lorentz's equations and the concepts of motion. This paper is a mathematical examination of the foundations of Lorentz's equations, with special reference to the time paradoxes which it is well known that they imply. As a result a group or family of similar equations emerges, among which Lorentz's form occupies a peculiar place. Other members of the family introduce no paradoxes and are equally competent to explain all the known critical experiments.—J. **Marshall**: The interior and exterior space-time forms of the Poincaré electron in Weyl's geometry. Forms for ds^2 are obtained from Weyl's gauging equation. Assuming $g_{11}=0$, the value of $\phi\mu$ is obtained, and arising from the ds^2 form, a pressure is shown to act inwards on the electron.

PARIS.

Academy of Sciences, May 14.—M. Albin Haller in the chair.—C. **Guichard**: The triple orthogonal systems of M. Bianchi. Application to a problem on reciprocal polars with respect to a sphere.—M. de **Sparre**: Concerning hammering in return mains.—J. L. **Walsh**: A theorem of algebra.—René **Garnier**: Uniform functions of two independent variables defined by the inversion of an algebraic system to total differentials of the fourth order.—Georges **Bouligand**: The singularities of harmonic functions.—H. G. Evans and H. E. **Bray**: Poisson's formula and the problem of Dirichlet.—J. **Haag**: The resolution of certain equations of Fredholm by means of an integral series.—Max **Morand**: The electromagnetic origin of inert mass and heavy mass.—Maurice **Nuyens**: Gravific field due to a massic sphere taking into account the cosmic constant.—Pierre **Steiner**: The ultra-violet absorption spectra of the alkaloids of the isoquinoline group: narceine. The ultra-violet absorption curve of narceine resembles generally that of narcotine and of opianic acid. The curve of hydrocotarnine is different from the preceding. So little as 0·05 milligrams of narceine in 2 c.c. of solvent can be detected spectrographically.—A. **Dauvillier**: High frequency spectrographic researches in the group of the rare earths. The results of a detailed examination of the L series of cerium, neodymium, samarium, europium, and gadolinium.—M. S. **Lambert**: Stereoradioscopy.—F. **Wolfers**: An appearance of reflection of X-rays at the surface of bodies.—Hector **Pécheux**: The magnetism of steels. An account of measurements made with three steels of varying carbon content. For forged annealed steels the permeability decreases with increase of carbon.—G. **Athanasiu**: The sensibility of photographic plates containing mercury salts. Of the mercury salts studied, the plates with mercuric iodide were the most sensitive, with a maximum in the green, the sensibility decreasing rapidly and uniformly with the wave-length. Curves are given showing the relation between the sensibility and the wave-length for mercuric and mercurous iodides, mercurous bromide, and chloride.—P. **Laffitte**: The formation of the explosive wave. A study of the explosion of carbon bisulphide and oxygen, utilising the photographic method of Mallard and Le Chatelier.—Alfred **Marx** and Jean **Rozières**: The purification of liquids by the simultaneous action of centrifugal force and the electric field. The removal of colloidal matters in suspension from liquids has been attempted by centrifugal force and by electrical fields, but neither method has completely solved the problem on the industrial scale. The use of an electro-centrifugal separator (2700 turns per minute, voltage gradient 4000 volts per centimetre), has proved successful with dirty transformer oil, the breaking down voltage being increased from 19,000 to 31,000 volts. This material remained practically unchanged when rotated at the same speed without an electrical field; the latter, without rotation, also proved ineffective.—Paul **Pascal**: The preparation of sodium metaphosphate at a low temperature. By the interaction of sodium ethylate and ethyl metaphosphate, sodium metaphosphate is produced at a temperature between 35° and 40° C. Its cryoscopic behaviour proves this salt to have the formula $NaPO_3$, differing from the polymers previously known. The salt may be heated to 800° C. without polymerisation.—**Pastureau** and H. **Bernard**: Tetramethylglycerol. The chlorhydrin $(CH_3)_2 . C(OH) . CHCl . C(OH)(CH_3)_2$, the mode of preparation of which has already been described by the authors, on treatment with an aqueous solution of potassium carbonate gives tetramethylglycerol.—Alfred **Gillet**: A verification of the antioxygen power of the polyphenols: relation between the fastness to light of dyes on the fibre and the presence in their molecule of the diphenol function (ortho- or para-). With the exception of pyrazolone dyes and cotton fabrics dyed with a copper mordant, great stability of dyes on fibre is closely related to the presence in the molecule of an *o*- or *p*- diphenol group.—Ph. **Schereschewsky** and Ph. **Wehrle**: The study of clouds by synoptic photography (the cloud week).—J. **Houdas**: The preservation of seeds in inert gases. Certain seeds (such as *Geubera Jamesoni*) lose their germinating power after exposure to air for a few weeks. In sealed tubes in an inert gas (hydrogen or carbon dioxide) the germinating power of seeds of this plant has been proved to be unchanged after eleven years. The seeds of other plants have given similar results.—L. J. **Simon**: The determination of carbon in arable soil. The method of wet combustion with silver bichromate is recommended.—J. M. **Lahy**: The graphical study of the stroke in typewriting. The speed of typewriting is a function of the alternation of the hands. No general rule can be given as to the number of fingers to be used; the touch is personal, and the most favourable mode of working can only be obtained by study of the individual.—Auguste **Lumière**: The toxicity of autolysates and of tissue extracts.—J. **Lopez-Lomba**: Changes in weight of the organs of the pigeon in the course of B-avitaminosis. The changes of weight in ten isolated organs of the pigeon fed with a diet deficient in B-vitamins are shown graphically.—**Samec** and V. **Isajevič**: The composition of glycogen. A comparison of the properties of starch and glycogen. There are various points of difference, the most marked being the higher proportion of phosphorus in the glycogen.—J. **Voicu**: The effect of humus in small and larger doses on the fixation of nitrogen by *Azobacter chroococcum*.—Alphonse **Labbé**: The influence of the increasing P_H of sea-water on the rapidity of segmentation of the eggs of Halosydna and Sabellaria.—Robert **Dollfus**: The trematode of mother-of-pearl in Provence mussels.—Foveau de **Courmelles**: The similitude of forms of shock in medicine, their dangerous but avoidable superposition. A discussion of anaphylactic shock produced by X-ray treatment, and means of avoiding it.

CAPE TOWN.

Royal Society of South Africa, April 18.—Dr. A. Ogg, president, in the chair.—C. von **Bonde**: Note on the Heterosomata (flat-fishes) of South Africa. Some abnormalities are discussed which are occasionally found in pigmentation, scales, etc., of flat-fish generally, and in particular in some new species described.—T. **Stewart**: Some notes on the drought of 1922–23 on Table Mountain. The first rainfall observations on Table Mountain were begun in January, 1881, when a gauge was placed at a spot called Disa Head, the elevation of which, above the sea-level, is about 2500 feet. Additional gauges were fixed, until by the year 1900 there were eleven in all. The average rainfall for 30 years on the highest portion of the mountain is about 75 inches. The average for the same gauges for 1922 was about 66¼ inches, and there were ten years of the 30 when the average was lower. On no previous dry season has the precipitation at Waai Kopje (elevation 3100 feet)—which gives results for 42 years—been so low as it has been for the seven months, September-March, 1923. If the Disa Head station is taken as indicating the conditions at the 2500 feet level, the dry seasons of 1883–84, 1919–20, and 1920–21 were drier than the last one.—J. S. **Thomas**: The sulphide and hydrosulphide of ammonium. By the action of hydrogen sulphide on alcoholic solutions of ammonia at 0° C., solutions were obtained in which the ratio $[NH_3]/[H_2S]$ approximated to 1; *i.e.* the solution consisted mainly of ammonium hydrosulphide. Ammonia reacts with ammonium hydrosulphide suspended in ether extremely slowly, but on the addition of a small quantity of alcohol a rapid reaction takes place and a heavy yellow oil separates, having the composition $(NH_4)_2S_2NH_3$. This substance is very unstable, and is extremely toxic. When this oil is allowed to stand, transparent cubic crystals separate for which the ratio $[NH_3]/[H_2S]$ was found to be 2. This substance appears to be anhydrous ammonium monosulphide.

Official Publications Received.

Annales de l'Institut de Physique du Globe de l'Université de Paris, et du Bureau Central de Magnétisme terrestre. Publiées par les soins de Ch. Maurain. Tome Premier. Pp. 323. (Paris: Les Presses universitaires de France.) 75 francs.

Scientific Papers of the Bureau of Standards. No. 465: Composition, Purification, and Certain Constants of Ammonia. By E. C. McKelvy and C. S. Taylor. Pp. 655-693. 10 cents. No. 466: Wave Length Measurements in the Arc Spectra of Gadolinium and Dysprosium. By C. C. Kiess. Pp. 695-706. 5 cents. (Washington: Government Printing Office.)

Annual Report of the Zoological Society of Scotland for the Year ending 31st March 1923. Pp. 24+8 plates. (Edinburgh.)

Ministry of Public Works, Egypt: Physical Department. Meteorological Report for the Year 1918. Pp. x+136. (Cairo: Government Publications Office.) P.T. 30.

County Borough of Eastbourne. Annual Report of the Meteorological Observations for the Year 1922. Pp. 24. (Eastbourne.)

Diary of Societies.

SATURDAY, JUNE 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. A. W. Hill: The New Zealand Flora.

MONDAY, JUNE 11.

VICTORIA INSTITUTE (at Central Hall, Westminster), at 4.30.—E. W. Maunder: The Two Sources of Knowledge: Revelation and Science (Annual Address).

TUESDAY, JUNE 12.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. J. B. Leathes: The Rôle of Fats in Vital Pheoomena. (Croonian Lectures (2).)

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—R. Broom: The Structure of the Skull in the Carnivorous Dinocephalian Reptiles.—N. A. Mackintosh: The Chondrocranium of the Teleostean Fish *Sebastes marinus*.—R. I. Pocock: The External Characters of Pigmy the Hippopotamus (*Chœropis liberiensis*) and the Suidæ and Camelidæ.—Major E. E. Austen: A Revision of the Family Pantophthalmidæ (Diptera), with Descriptions of new Species and a new Genus.—R. Dart and Dr. C. W. Andrews: The Brain of the Zeuglodontidæ (Cetacea), with a Note on the Skulls from which the Endocranial Casts were taken.—O. Thomas and M. A. C. Hinton: Mammals collected by Capt. Shortridge during the Percy Sladen and Kaffrarian Expedition to Orange River.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Dr. P. B. Ballard: The Validity of certain New Methods of Testing.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—J. Burton: Notes on Fixing, Staining, and Mounting Freshwater Algæ.—Secretary: Notes on Mounting and Report of Petrographical Interest on the Deposits sent by Mr. Hamm to the Club.—J. H. Barton: Demonstration of a New Form of Microscope.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Rev. W. H. Leembrugger: Social Transitions among the Natives of New Georgia, Solomon Islands.

THURSDAY, JUNE 14.

ROYAL SOCIETY, at 4.30.—Dr. C. Chree: Magnetic Phenomena in the Region of the South Magnetic Pole.—O. R. Howell: The Catalytic Decomposition of Sodium Hypochlorite by Cobalt Peroxide.—Nina M. Hosali: The Seismic Waves in a Visco-Elastic Earth.—J. W. Landon and H. Quinney: Experiments with the Hopkinson Pressure Bar.—S. F. Grace: Free Motion of a Sphere in a Rotating Liquid at Right Angles to the Axis of Rotation.—B. F. J. Schonland: The Passage of Cathode Rays through Matter.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. J. B. Leathes: The Rôle of Fats in Vital Phenomena. (Croonian Lectures (3.))

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—S. G. Starling: Levels and Level Bubbles.—T. F. Connolly: A New Form of Balloon Theodolite.—E. W. Taylor: The Primary and Secondary Image Curves formed by a Thin Achromatic Object Glass with the Object Plane at Infinity.

CHEMICAL SOCIETY, at 8.30.—Prof. C. Moureu: Les gaz rares des sources thermales, des grisous et autres gaz naturels (Lecture).

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. L. R. Yealland: Hysterical Fits, with some reference to their Treatment.

FRIDAY, JUNE 15.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir John H. Marshall: The Influence of Race on Early Indian Art (Sir George Birdwood Lecture).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Mr. and Mrs. D. E. Batty: A Simplified Method of Printing in the Gum-Bichromate Process (with a Demonstration).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: The Life History of an Alpha Particle from Radium.

SATURDAY, JUNE 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (VI.).

PUBLIC LECTURES.

MONDAY, JUNE 11.

UNIVERSITY COLLEGE, at 5.—N. Fryer: Unknown Central Europe.

TUESDAY, JUNE 12.

ST. BARTHOLOMEW'S HOSPITAL MEDICAL COLLEGE, at 5.—Dr. A. Balfour: Tropical Hygiene. (Succeeding Lectures on June 14, 19, and 21.)

WEDNESDAY, JUNE 13.

UNIVERSITY COLLEGE, at 5.30.—J. C. Gröndahl: Norwegian Literature of the Present Day.

THURSDAY, JUNE 14.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 4.30.—Prof. G. Dreyer: Some New Principles in Bacterial Immunity and their application to the Treatment of Refractory Infection.

NATURE

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*" To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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The Organisation of Research in India.

THE remarkable results that have been achieved in recent years in India by scientific plant-breeding are strikingly illustrated by a table contained in "A Review of Agricultural Operations in India," recently published by the Government of India (Calcutta: Superintendent of Government Printing, 1923).

In the season 1921-22 the area under new and improved varieties of crops was returned at nearly $3\frac{1}{2}$ million acres. To this should be added a large area (particularly of wheat and cotton) laid down with seed obtained from other sources than official Seed Depots. Of the above-mentioned area, no less than approximately $1\frac{1}{4}$ million acres were under improved cottons, yielding in some cases an increased profit to the cultivators of 20*s.* per acre. But in regard to this crop, Indian administrators are still not satisfied with the progress made. An Indian Central Cotton Committee was appointed to examine the whole problem of cotton growing and marketing. This Committee reported in August last, and already the Indian Government has adopted one of its recommendations and passed an Act authorising the levy of a cess of 4d. per bale of cotton exported and consumed in mills, the money so raised to be used to create a Central Fund for Cotton Research.

It is estimated that this cess will produce about 45,000*l.* per annum (or one-and-a-half times the total amount originally set aside for agricultural research in Great Britain by the Development Commission). The greater portion of this sum will be devoted to the creation of a Cotton Breeding and Seed Distribution Institute, to be established, probably at Indore, in Central India. In addition, a definite scheme for research in technological problems has been formulated. An experimental spinning plant will be provided for this purpose. Further, an information bureau has been started for the collection and distribution of trade and agricultural information. It is probable that the central breeding station at Indore will be placed under the direction of Mr. and Mrs. Howard, whose successful work at Pusa in wheat-breeding is well known in Great Britain.

The Central Cotton Committee has also been instrumental in securing the enactment of measures designed to cope with the difficulties peculiar to the improvement of the cotton crop. Cotton being a plant which, usually, is cross-fertilised, an improved variety cannot be handled in a small way. Consequently, an Act has been passed which gives the Government power to notify a particular area (generally 2000 square miles) for protection, and so prevent, over a large region, the sowing of any variety other than that which it is desired to introduce. The official regulation of cotton "gins" and presses is also likely to be introduced.

All these measures are an example of energetic and purposeful action taken by Government, under the inspiration of results achieved by research in the interests of agriculture. The progress already made has, no doubt, been favoured by the great field which the Indian crops provide for plant improvement. (There is no space to tell of the achievements in the breeding of sugar-cane, but the distressed agriculturists of Great Britain will read with envy of a crop of an improved variety of sugar-cane yielding 60 tons of raw cane per acre, as against a normal 20 tons, worth at a moderate estimate 60*l*.) But when favourable conditions are allowed for, there remains the fact that the Government appreciates, and has been quick to develop economically, the results of scientific work. It was not content to let these results rest at the laboratory stage.

What could be accomplished by similar methods in Great Britain it is difficult to say; some remnants of enlightened despotism still linger in India, and can be used quickly and effectively in the interests of progress; but it might be worth considering whether in the present sorry plight of agriculture some measure of action similar to that followed in India could not be taken. In particular, the idea of creating a research fund by the levy of a cess on the product that it is desired to improve may be worthy of consideration. Bacon, cheese, butter, wool, flax are examples of products that are imported into Britain in large quantities, to the detriment of the home producer. Is organised research powerless to help? There can be no doubt as to the answer, but our politicians, while ready to give lip-service to the value of "education and research," and even grants of money in aid of experimental work, have failed to show an adequate appreciation of the need of *following up* the achievements of research by administrative action, such as that so effectively taken by the Government of India.

Shield Tunnelling.

Shield and Compressed Air Tunnelling. By B. H. M. Hewett and S. Johannesson. Pp. x+465. (New York and London: McGraw-Hill Book Co. Inc., 1922.) 25*s*.

OF late years engineers have been driven more and more to find a location for railways, roadways, and large water-mains below the surface of the ground. In cities, by going underground the cost of acquiring valuable property is escaped. In crossing rivers, a tunnel may be less expensive than a bridge. A method has been devised for tunnelling in soft or water-bearing ground in which the miners work in a shield and an inrush of water is prevented by compressed air. In this method rings of cast-iron segments are erected in the shield, forming a water-tight lining, and as each section is completed the shield is driven forward by hydraulic jacks, leaving the lining to support the rock or earth. The more difficult the ground the greater is the advantage of this method of working. The number of tunnels which have been so driven in different countries is now large, but though the method is simple in principle the difficulties and dangers met with in carrying it out are among the most serious which tax the skill and experience of the engineer and contractor.

Information about shield tunnelling is scattered in the proceedings of professional societies, and the treatise of Messrs. Hewett and Johannesson is one of the first in which the data of past experience are gathered together and the attempt is made to formulate principles and rules of practice. It is an excellent treatise, full of information, well illustrated, and competently discussed.

Brunel patented the first shield, and by its help overcame the very great difficulties of driving the first tunnel under the Thames (1825–1843). In 1869, Barlow promoted the construction of the Tower Subway for foot passengers under the Thames. When contractors feared to undertake the work, a young engineer, Greathead, designed a new form of shield and completed the tunnel in a year. This was in dry London clay. Then, when such difficulty was experienced in driving the two Hudson River tunnels in water-bearing silt at New York that the work was temporarily abandoned, Greathead and Baker carried it on for 2000 feet by a shield and compressed air. Stopped again by want of capital, the tunnels were completed in 1904 by Jacobs. Later the Blackwall and Rotherhithe tunnels under the Thames and others abroad were successfully constructed by the same method. Descriptions of these and a full bibliography are given in this treatise.

The cast-iron lining for shield-driven tunnels is now in general use. The space between the lining and ground is filled by cement grout, forced by compressed air through holes in the lining, and the interior is made fair by brick or concrete. The joints of the lining are caulked with rust cement. There is a bulkhead behind the shield through which the compressed air is forced, and it contains airlocks for men and materials. The shield is driven forward by hydraulic jacks, working with pressures up to 6000 pounds per sq. in. and exerting a total force amounting to 6000 tons in some cases. Usually in the shield is a hydraulic erector for lifting and placing the cast-iron segments and mechanical excavators for removing the soil at the face. It may give an idea of the complex arrangements necessary if it is stated that among the equipment required are a low-pressure plant for supplying air to keep back the water; a high-pressure plant to supply compressed air for working rock drills and other tools; a service water supply for grouting and washing; an electric light and power supply; and transportation plant. A useful chapter is one on the working force needed, the rate of progress in different cases, and the cost.

The authors give a theory of the stresses in the tunnel lining, a subject hitherto far too much neglected, designs having followed rule-of-thumb methods. This is not a suitable occasion for discussing a mathematical theory. The mode of treatment is unusual, but the results are interesting. The authors seem to underrate the erection stresses due to the weight. The most important external load is the earth pressure. The theory of earth pressure of Rankine is adopted, in which c depending on the angle of repose is the ratio of the "active" horizontal pressure to the vertical pressure and $1/c$ the ratio of the "passive" resistance of the earth, if the structure presses against it and is on the point of displacing it. But the statements (p. 76) that if the active horizontal pressures are not sufficiently large in relation to the vertical pressures the tunnel will have a tendency to deflect horizontally, and (p. 53) that if k lies between c and $1/c$ the tunnel lining will not be subject to a moment, require more justification.

An interesting chapter is that on compressed-air illness and the precautions to prevent it. The cause is the absorption of an excess of nitrogen by the blood—disengaged if the pressure is reduced. The cure is careful limitation of the period of work and slow decompression. If in spite of precautions cases of illness occur, the remedy is to recompress and decompress more slowly. For this a hospital lock is provided.

W. C. U.

Colour Vision and Colour Vision Theories.

(1) *Colour Vision: A Discussion of the Leading Phenomena and their Physical Laws.* By Prof. W. Peddie. Pp. xii+208. (London: E. Arnold and Co., 1922.) 12*s.* 6*d.* net.

(2) *Colour and Methods of Colour Reproduction.* By Dr. L. C. Martin. With Chapters on Colour Printing and Colour Photography, by William Gamble. Pp. xiii+187. (London, Glasgow and Bombay: Blackie and Sons, Ltd., 1923.) 12*s.* 6*d.* net.

THERE are no subjects on which discussion and demonstration are more needed than those of vision and colour vision. The trichromatic theory as presented by Helmholtz was the best theory in relation to the facts known at the time, but the difficulties of the theory were thoroughly recognised by him. That it was a theory and not a fact was stated by Helmholtz. That all colours can be matched by a mixture of three selected simple colours is a fact, but the statement that there is an underlying trichromatic basis is not only not a fact, but it is also not supported by any fact which cannot be explained in another way, and there is the most conclusive evidence that this is not the case, while another explanation is completely consistent with the facts. The state of chaos existing in many minds with regard to colour vision is due to the assumption that the trichromatic theory is a fact. If the theory be denied there is no evidence for it, and this was known to Helmholtz.

(1) Prof. Peddie's book is an uncompromising acceptance of the theory as a fact. The book is an admirable exposition of the functions of three variables, but no attempt is made to answer any of the objections to the theory or to show how the theory is consistent with known facts. In this respect the author differs from other writers, who admit that something more is required. If we regard colour perception as developed secondarily to light perception, as it undoubtedly was, we can form a series from total colour blindness to super-normal colour perception. The colours differing most physically in wave-length being first discriminated, these gradually approached each other until green was discriminated in the centre as a new colour, then yellow, then blue, then orange, and lastly indigo. The explanation, therefore, why red and green make yellow when mixed is, that yellow having replaced the red-green of a previous state of development, the colour perception is not sufficiently developed to discriminate between a mixture of red and green and simple yellow.

No two accounts of the trichromatic theory agree, and the theory is loaded with subsidiary hypotheses, many of them quite inconsistent with each other; that is to say, one will explain one set of facts but not another set of facts for which a different arrangement is required. Space will not permit of more than a few of the very long list of objections to the trichromatic theory being given here. If a mixture of spectral lights red, green, and violet be made to match a simple white, on the trichromatic theory the internal physiological processes should be identical; but if the eyes be now fatigued with a red light containing that used in the mixture, about twice as much green will be required in the mixed white, the mixture appearing bright green to a normal person with unfatigued eyes. Again, if a spectrum be viewed with an eye fatigued by looking at burning sodium, the yellow will have disappeared from the spectrum and the red and green will appear to meet, but a feeble red at the end of the spectrum will be quite visible. If, however, after looking through a deep-red glass for the shortest possible time the terminal red be viewed, it will not be visible. On the trichromatic theory much greater fatigue of the red sensation process is obtained with the burning sodium.

When we come to colour blindness, which, according to Helmholtz, is the key of colour vision, the trichromatic theory fails completely to explain any case when it is fully and thoroughly examined. How, for example, does it explain that more than 50 per cent. of the dangerously colour blind can get through the wool test? How are the innumerable cases of dichromic vision to be explained? All see in the spectrum two simple colours and a neutral region, but one is only detected by very efficient tests, others by very rough tests: the latter are obviously much more colour blind than the first class. How are the trichromic, with their absence of the yellow sensation and wide monochromatic area in the yellow region—for example this may be from $\lambda 610\ \mu\mu$ to $\lambda 535\ \mu\mu$—to be explained? How is it that in so many cases the apex of the luminosity curve remains at the normal point and a normal white equation is made? Why, indeed, should a man who has three colour sensations be colour blind at all? As a matter of fact, there is considerable variation in colour perception without colour blindness; a man may make an anomalous white equation without being colour blind.

Finally, it can be clearly shown that, with a man having a defective terminal red, this is not due to a diminution of a hypothetical red sensation which is affected by rays corresponding to every part of the spectrum. For example, a man may have shortening of the red end of the spectrum; he may pass the wool test, or if the proper colours be there, put certain pinks and violets together as identical. Shown a bright red in the lantern corresponding to the shortened portion, he does not see it at all. It will be noticed that the pinks he puts with the violets are much lighter than the latter, but when viewed through a blue-green glass both appear identical in colour and shade to the normal-sighted. The blue-green glass has cut off the red rays. How, according to Prof. Peddie's construction, can a man with shortening of the red end of the spectrum pick out yellow at the normal point and have a luminosity curve with the normal apex?

The valuable work of Shelford Bidwell, which is so inimical to the trichromatic theory, is not mentioned. Bidwell showed that the phenomena of intermittent light are quite inconsistent with the compound character of the yellow sensation. If the image of a white object be formed suddenly on a portion of the retina which was previously occupied by the image of a black object, this image is surrounded by a red border. Bidwell states: "Though the image of the needle was colourless when the patch was illuminated by the greenish-yellow rays of the spectrum, it appeared red when the same hue was formed by combining red and green rays." The fact that the red border is not found with the pure greenish-yellow spectral light and is found with the compound light is strong evidence against the compound nature of the yellow sensation when caused by simple yellow light.

(2) The valuable book by Martin and Gamble should be read by all interested in colour. It is very well written, and gives an admirable account of the facts and views of different writers, without bias towards any particular theory. Dr. Martin states in the preface: "It is now more than ever necessary that the limitations of the trichromatic theory shall be explored, still by physically sound methods but by men who are fitted to understand the psychological and physiological view points. Furthermore, there is a great deal of work which needs the most careful verification and checking."

The book is divided into three sections. Part one deals with the nature of light and colour, colour analysis and synthesis, the colours of material objects, their nomenclature and measurement, colour in regard to illumination, colour in human experience, and colouring materials. This part is so clearly written that it can be easily understood by any one who has not much knowledge of physics and mathematics. Part two deals with the eye and its reactions to light, photometry, instruments for colour measurement, colour vision with an account of the principal theories, and colour blindness. Part three is written by Mr. Gamble, and deals with colour printing and photography in colours. A number of useful tables are given in an appendix.

Nature Knowledge and Pastime.

(1) *Great and Small Things.* By Sir Ray Lankester. Pp. xi + 246. (London: Methuen and Co., Ltd., 1923.) 7*s.* 6*d.* net.

(2) *The Badger: Afield and Underground.* By H. Mortimer Batten. Pp. 159 + 12 plates. (London: H. F. and G. Witherby, 1923.) 8*s.* 6*d.* net.

(3) *A Perthshire Naturalist: Charles Macintosh of Inver.* By H. Coates. With a chapter on Scottish Folk-music by H. Wiseman. Pp. xx + 244 + 32 plates. (London: T. Fisher Unwin, 1923.) 18*s.* net.

(4) *The Highlands with Rope and Rucksack.* By Dr. E. A. Baker. Pp. 253 + 19 plates. (London: H. F. and G. Witherby, 1923.) 12*s.* 6*d.* net.

(1) THE volume before us is the fifth, if we are not mistaken, in a series of volumes whereby Sir Ray Lankester has rendered notable service to those persons who, though debarred by circumstance from undertaking sustained research, deeply sympathise with advance in natural science, are eager for sound informa-

tion, and grateful to a competent showman, so to speak. In the present volume the author ranges wide—from the gorilla which, having spent its childhood in devoted attachment to a lady in Sloane Street, sickened and died when she was obliged to part with him, to the parasites of a pond snail and Metchnikoff's investigation of the means of making old age still older. The title of the book is well chosen, for it contains the conclusions of a trained intellect upon such great problems as the suffering inseparable from the existence of all animals, and upon such small ones as the relative advantage (or otherwise) of the different ways of using tobacco. Even those smokers who display little interest in chemical science, though rightly regarding nicotine as the chief toxic agent in tobacco, may feel relieved in learning that "it is a colourless volatile liquid, which is vaporised and carried along with the smoke," and not the malodorous oily juice that collects in the stem of a foul pipe or the stump of a cigar.

Elderly folk who were reared in the belief that they had to work their way through life equipped with only five senses—sight, hearing, smell, taste, and touch—may be surprised to learn that all the time they have been served by double that number. Increased knowledge of physiology has revealed the existence in the human frame of a distinct apparatus and separate nerve-threads for the perception of heat, cold, and pain, for muscular contraction and for the maintenance of equilibrium, all of which—except the last, which escaped consideration—were of old roughly assigned as functions of the sense of touch.

Sir Ray Lankester points out that the most salient anatomical difference between man and the gorilla is in the structure of the foot. In man the axial line of the posterior limb passes straight down the shin-bone to the hallux or great toe; whereas in plantigrades, such as bears and anthropoid apes, it is directed between the third and fourth digits, leaving the hallux to be deflected and developed into a powerful grasping organ. The importance of this difference consists in the absence of any trace of a form of foot intermediate between that of man and the ape.

This volume, like its predecessors in the series, is written with lucid fluency, is admirably illustrated, and many readers will pass a hearty vote of thanks to the author for having devoted his well-earned leisure to their profit.

(2) In his great work on British and Irish mammals, Mr. J. G. Millais apologised for having quoted at so great length from Sir Alfred Pease's treatise on the badger, which had rendered it scarcely possible to write anything new upon that subject. While Mr. Mortimer Batten can scarcely claim to have made fresh addition to our knowledge of the habits of this most cryptic creature, he has recorded in very readable form his own patient observation thereof, confirming much that has been written by other naturalists and giving his own views upon points whereon these have differed. He considers the badger to be "the most abused and misunderstood of British wild beasts," quoting the sickening treatment of the animal prescribed by Nicholas Cox in the sixteenth century before baiting it with terriers. "Cut away the nether jaw, but meddle not with the other, leaving the other to show the fury of the beast, although it can do no harm therewith." Drawing the badger, a so-called sport which it is to be feared is still in vogue as a clandestine pastime, was made illegal by the Act of 1850; but unfortunately there is no law against "trying" terriers on a captive badger.

Sir Alfred Pease stated that the badger had become rare in Scotland and had "entirely vanished" from the north-east of that country. Mr. Mortimer Batten, however, has satisfied himself that the race survives in far greater numbers than most people think, founding his opinions not only on the badgers which he has himself found, with his terriers, in cairns, but also on the great preponderance in some hill districts of the tracks of badgers in snow over those of foxes.

Naturalists have differed widely in estimating the period of the sow badger's gestation. Mr. Millais accepted fifteen months as possible, at least for a badger in captivity; Sir Alfred Pease put it at nine months, Tom Speedy at seven, Sir Harry Johnston at six; but Mr. Batten gives good grounds for agreeing with Capt. Salvin that the normal term is eleven or twelve months. He rejects the supposed analogy with the roe, which has been credited with the power of postponing parturition until circumstances are suitable for her.

"What really does happen in the case of the roe is this—the embryo does not develop, or at least develops very slowly, during the first four months of pregnancy, so that she carries her young close upon four months longer than is normal. This peculiarity of the roe is probably owing to a total change of environment—that is, the animal originated under semi-tropical conditions, and migration northward during [? after] the glacial age led to a postponement in the operation of parturition."

This may pass for speculation on an obscure problem; the value of Mr. Mortimer Batten's book consists in the convenient manner in which he has summarised all that is known of one of our larger wild animals, subject to critical light from his own observation, and has supplied excellent photographs and explanatory cuts.

(3) Charles Macintosh was of a type not infrequent among the Scottish peasantry—men self-taught in some branch of natural history; keen observers but ill-equipped with appliances and books of reference,

patiently accumulating facts until, in middle life or past it, some happy accident brings their work to the knowledge of those whose scientific standing enables them to advise and assist. Probably there are and have been many "mute, inglorious" Tyndalls and Huxleys to whom such chance never came; but just as the labours of Robert Dick of Thurso on the Old Red Sandstone were recognised and redeemed from oblivion by Hugh Miller and Sir Roderick Murchison, so when Dr. Buchanan White started in 1872 to investigate the mycology of Perthshire he found that Macintosh, a humble rural postman on a weekly wage of 12*s.*, had gone far to make a complete collection of the Basidiomycetæ, and straightway enlisted him as an auxiliary and correspondent of the Perthshire Society of Natural Science.

Charles Macintosh was born in 1839, the son of a handloom weaver in the village of Inver, near Dunkeld. When he was sixteen years old he obtained employment in a sawmill, and two years later met with an accident that deprived him of all the fingers and the thumb of his left hand. In 1858 he was appointed post-runner in the district between Dunkeld and Ballinluig—a sylvan and riparian region most congenial to one with his bent for botany and natural history. His daily round afoot was about 16 miles, enough, it might be thought, to abate inclination for serious work when off duty; but

"ingenium res
Adversae nudare solent,"

and Macintosh's appetite for knowledge was insatiable. With the aid of a very imperfect microscope and a few antiquated works on botany, by the time he became acquainted with Dr. Buchanan White in 1872 he had made a very extensive collection, not only of the flowering plants, but also of the ferns and other cryptogams of Strathtay. After that, having supplied himself out of his savings with better instruments and modern books, he contributed several additions to the flora of Perthshire, including seventeen species of fungus hitherto unrecorded in Britain, of which four were new to science, namely, *Curreyella aucupariæ*, *Melogramma elongatum*, *Ascobolus Carletoni*, and *Ombrophila megalospora*. He finished 32 years' service under the Post Office in 1890, and died in 1922.

Mr. Coates has done full justice to the subject of this memoir, which is very fully illustrated, the frontispiece being an exceptionally interesting photograph of Macintosh. We have noted very few slips: the great oak at Birnam may possibly be a survival of the primeval forest, but not so the sycamore (p. 60), for that is not an indigenous species. Both trees are well known to the present writer, and to estimate their age at one thousand years is to disregard what is obviously their vigorous prime. To describe a family bible as "a human document" (p. 11) is grievously to misapply a metaphorical phrase. Lastly, widely as the spurious adjective "phenomenal" has come into use in the sense of "extraordinary," to describe the Tay as having been reduced by drought to "almost phenomenally small proportions" (p. 221) is surely neither sense nor English!

(4) A certain German philosopher is credited with the doctrine that every object of interest should be inspected from its proper point of view—a church from the outside, a tavern from the inside, and a mountain from the bottom. Whatever may be Dr. Ernest Baker's opinion about churches and taverns, he holds emphatically that the worst aspect of a mountain is from the bottom. Its only legitimate purpose is to be climbed on its most difficult side. The first fifty pages of his treatise on "the excellent sport of rock-climbing" are applied to a denunciation of Highland landowners for putting difficulties in the way of tourists and trippers, but for which he is confident that the Scottish Highlands would attract as many holiday folk as Switzerland does.

Dr. Baker's own narrative testifies to the fact that the summer climate of the Highlands is scarcely so serene as that of Switzerland. In his adventures among the Highland hills he encountered many spells of dismal weather.

"We were awake betimes, but rain was falling, and for three long days the weather remained too bad for serious climbing. Stob Dearg was continuously swathed in mist; and the gullies, as we could see afar off by the tracks of white, were spouting water amain" (p. 78).

As for landowners, there are no doubt surly ones as well as others of milder mood; but the powers of both in preventing access to their estates are more strictly limited than Dr. Baker explains. They can only proceed against trespass by obtaining interdict against individuals. "Trespassers will be prosecuted" is *brutum fulmen* unless damage can be proved. It may be doubtful whether a judge would decide that damage had been done in the incident described as follows; but the immediate consequences might have been serious if the Highland glens had been as full of holiday-makers as the author would like to have them.

"As usual on a new climb, we found many splinters hanging in dangerous places, and the worst of them we cleared away. One big lump of porphyry, caught in unstable equipoise on the bevel-end of a ledge, gave rise to a memorable incident. I was held from above by the rope while I gave the rock a final shove that released it. Thirty feet below, a pinnacle stood out from the face, a squarish mass some twenty-five feet in height and about sixteen in girth. It is discernible in the photo taken near the foot of the climb, but its place knows it no more. . . . We calculated afterwards that it would weigh 80 or 90 tons. . . . The falling rock hit the top of it. The pinnacle shook in its socket, lurched forward, bowed majestically over, and, almost before we knew what was happening, went hurtling down the cliffs and gullies. It cleared some hundreds of feet at a leap; then striking a projection, bounded off, leaving an ugly scar behind, and thundered on down the crags, smashing off corners, crashing into the screes in the gullies and splashing up the snow like water. . . . The whole ridge vibrated like a bridge with a heavy express rushing over."

Pretty pastime! yet landowners are but human after all, and might not unreasonably demur to much of this kind of thing. There is no evidence that in his scrambles Dr. Baker took any notice of geology, botany, or anything except the opportunity for hazardous athletics. His book is illustrated with many good photographs of hill scenery.

Herbert Maxwell.

Psychotherapy.

Suggestion and Mental Analysis: An Outline of the Theory and Practice of Mind Cure. By Dr. William Brown. Third edition, with Index. Pp. 176. (London: University of London Press, Ltd., 1923.) 3*s*. 6*d*. net.

As implied by the title, Dr. Brown's "Suggestion and Mental Analysis" brings together the widely divergent views of the two principal schools of psychotherapy. It is an attempt to harmonise the theory and practice of the hypnotists, suggestionists, and autosuggestionists, on one hand, and of the psycho-analysts on the other. It is generally claimed by the partisans of each school that its method is exclusively the best suited for the treatment of those forms of psychoneuroses in which mental therapy is indicated. Indeed, as Dr. Brown points out, extremists of both schools agree in disclaiming any possibility of a synthesis of their methods. In practice, however, it not seldom works out that such disclaimers are ignored, even by the purists. Dr. Brown argues that the various methods of psychotherapy can be advantageously employed in combination. He bases his views upon a very large number of typical clinical cases which have passed through his hands both in civilian practice and as a result of the special conditions due to the War. With regard to the latter cases, Dr. Brown worked mainly by suggestion and hypnosis, and with marked success. He now advocates a judicious use of all the methods, some of which are more especially adapted to one type of case and some to others. He thus, on empirical grounds, declares himself to be an eclectic.

The book is elementary—even popular—but it touches upon most of the points which are treated at length in the large and continually growing literature of psychotherapy. The first chapters deal with generalities on suggestion and the subconscious, and sketch briefly the theories and methods of the analysts. Several interesting case-histories are given in some detail to illustrate the dissociation due to hysteria and hysterical epilepsy. Hypnosis is contrasted with suggestion, and is itself declared to be a form of dissociation; in consequence of which the conclusion is—rightly—drawn that frequent hypnotising of a patient is dangerous. Nevertheless, hypnosis is a valuable procedure to employ in certain cases. Indeed, all proved methods are valuable. This is the general conclusion of the book, in which such divergent views as those of Charcot, Bernheim, Freud, Jung, Coué, and others are considered.

The more scientific and therapeutic part of the volume is supplemented by three chapters on the "philosophical background," which consist of a summary exposition and criticism of the philosophy of M. Bergson. It is true, as Dr. Brown remarks, that "every revolution in scientific theory synchronises closely with the development of new ideas, and even new systems, within the domain of philosophy"; and no doubt Bergson's philosophy synchronises to some extent with the rise and growth of recent psychotherapeutic theory and practice. There are obvious similarities in both. But it is not obvious why these chapters should have been included in a book on psychotherapy; and their inclusion makes it appear rather overweighted with speculation. The present is the third edition of the book; and it is clear that this excellent elementary presentation of the theory and practice of "mind cure" meets the good reception it deserves at the hands of the public. There is a good index.

Our Bookshelf.

Cements and Artificial Stone: a Descriptive Catalogue of the Specimens in the Sedgwick Museum, Cambridge. By the late John Watson. Edited by Dr. R. H. Rastall. Pp. xii+131. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1922.) 6*s*. net.

The collections brought together by the zealous care of Mr. Watson in the Sedgwick Museum have been of great service in technical geology. Probably much may still be added to the samples of cement and artificial stone described in the present volume, as these materials become still more favoured by architects and engineers. The labour and art of the mason may decline, but the production of durable cements for covering walls, the colouring of them until they surpass in brilliance the painted surfaces of Roman times, and the imparting of increased delicacy to moulded work in stucco, are alike honourable and artistic occupations. The materials of artificial slabs are largely natural rock, brecciated or pulverised, but otherwise untreated, and the pride of their makers lies in the production of monolithic blocks of more uniform texture and more free from cracks than can be obtained from ordinary quarries. Mr. Watson (p. 76) gives an impressive account of the hollow blocks of reinforced concrete, each weighing 2464 tons, and measuring 66 by 53 by 50 feet, used in harbour-construction at Valparaiso in 1917. It seems as if a house of considerable size, with staircases and passage-ways, could now be moulded round a light steel framework as a single piece, and transported by flotation to any quarter of the globe.

The author shows (p. 94) how well-known building-stones, with their pleasing colours, are already successfully imitated, and how a great field lies open before the manufacturer of light roofing-tiles that may compete in our towns with the monotonous grey tints of slate. Nothing is likely to oust polished granite from its supreme place as a decorative stone for towns; but those who would decry the use of artificial stone must remember that the glories of Verona, the Hansa Towns, and Hampton Court are largely due to the manipulation and moulding of detrital clay. Mr. Watson gives a long and interesting history of the Portland cement industry, which his specimens fully illustrate. He directs attention (pp. 101 and 114) to the good acoustic properties of selenitic cement for lining walls; but we cannot find a mention of the remarkable cement now formed from magnesite and used for floors. The early use of the Italian *pozzolana* (which even the "Encyclopædia Britannica" spells in places *pozzuolana*) is well mentioned; but we doubt if (p. 2) Puteoli was also known to the Romans as "Putevolano." G. A. J. C.

Special Steels: a Concise Treatise on the Constitution, Manufacture, Working, Heat Treatment, and Applications of Alloy Steels, for Students, Operators, and Users of Special Steels. Chiefly founded on the Researches regarding Alloy Steels of Sir Robert Hadfield. By Thos. H. Burnham. (Pitman's Technical Primers Series.) Pp. xxii + 194. (London: Sir Isaac Pitman and Sons, Ltd., 1923.) 5*s*. net.

THIS small volume is a welcome addition to the literature dealing with special steels, as it contains a large amount of useful information compressed into a small compass. The necessity for economy in the use of iron ore is clearly indicated both by Sir Robert A. Hadfield and the author, who show that, by the use of special steels, the amount of iron necessary for most purposes is greatly reduced.

Considerable information is given relating to the constitution and manufacture of special steels and to their later heat or other treatment. Much useful work has been done during the past twenty years in connexion with the heat treatment of ordinary carbon steel, but this treatment, in the case of large masses, is always unsatisfactory on account of the impossibility of bringing about uniform structural changes. If, however, carbon steel is alloyed with other elements a considerably greater range of mechanical and other properties is available. These considerations are dealt with in this small book. Accounts are given of various classes of special steels, while under "chromium steel" details are given relating to rustless steel, such as its composition, mechanical and heat treatment, mechanical properties, resistance to corrosion, and its applications. A chapter each is devoted to silicon, manganese, and tungsten steels, while some details are given respecting the manufacture, properties, and uses of other types of special steel. The final chapter (xii.) points out the general trend of progress, and there are four appendices which deal respectively with: (1) carbon steels; (2) a classified list of papers by Sir Robert A. Hadfield; (3) a list of symposia of the Faraday Society; and (4) the relation between hardness number and shock qualities, tensile strength and compression strength of various types of steel.

The book provides the student and the practical man with a handy survey of the subject, and should find a place in all technical libraries. W. H. M.

(1) *Animal Nutrition: Foods and Feeding.* By E. T. Halnan. Pp. 52. 2*s*. net. (2) *Farm Costing and Accounts.* By C. S. Orwin. Pp. 31. 1*s*. 6*d*. net. (3) *Insect Pests and Fungous Diseases of Farm Crops.* By A. Roebuck. Pp. 55. 2*s*. net. (4) *Poultry Keeping on the Farm.* By Edward Brown. Pp. 54. (London: Benn Bros., Ltd., 1923.) 2*s*. net.

THE four little books under notice belong to the "Successful Farming Series," the purpose of which is "to raise the standard of British Farming in all its branches."

Even in this small compass Mr. E. T. Halnan (1) has developed the subject of animal nutrition from the fundamental scientific facts to the practical deductions drawn therefrom. The exposition is lucid, and the book should not only interest farmers who have no scientific knowledge, but it should also be of real use to them in their daily work.

(2) In "Farm Costing and Accounts," by Prof. C. S. Orwin, simple methods are given for keeping financial accounts suited to the needs of almost any farmer—and incidentally sufficient for purposes of reclaiming excess income tax—and an outline of the methods of keeping the more intricate costing accounts.

(3) "Insect Pests and Fungous Diseases of Farm Crops," by Mr. A. Roebuck, contains descriptions of the common insect pests and the appearances of plants attacked by them or by various fungi. The writer suggests prophylactic measures such as balanced manures, and the avoidance of harbouring places for pests such as are found on untidy and ill-kept farms and buildings.

(4) In "Poultry Keeping on the Farm," Mr. Edward Brown emphasises the possibility of increasing very greatly the number of poultry kept in this country. In his opinion this increase can take place most profitably on farms, where the birds could find much of their food; but he maintains that there are also big openings for specialised poultry keeping, more especially in the vicinity of large towns, and for selective breeding.

The Elementary Principles of Lighting and Photometry. By J. W. T. Walsh. Pp. xvi + 220. (London: Methuen and Co., Ltd., 1923.) 10*s*. 6*d*. net.

MR. WALSH's book may be regarded as a useful supplement to pre-War works on illumination. The text may be conveniently divided into four main sections. We have first an account of the effect of light on the eye, followed by an explanation of terms and elementary principles. Next there are chapters dealing with various aspects of photometry, leading to a discussion on calculations of illumination. Finally we have, in the second half of the book, a general discussion of practical lighting problems. Consideration of the human eye forms a natural starting-point, and in general a logical sequence of subjects is adopted. One may question, however, whether the separation of heterochromatic photometry and the flicker-photometer in the penultimate chapter is desirable. Surely this might more fitly have been included in the earlier section of the book dealing with photometry in general? Mr. Walsh's experience at the National Physical Laboratory has stood him in good stead in dealing with this phase of the subject. The hints on laboratory practice are sound, and there is a useful description of the chief forms of illumination-photometers. It is interesting to note that, with proper precautions, an accuracy of 2-3 per cent. is considered possible with this class of instrument. The chapter on industrial lighting contains a useful survey of the work of the Home Office Departmental Committee on Lighting in Factories and Workshops, and the contents of various American codes. One is glad to note the inclusion of a chapter on daylight illumination, which is now being studied in a more scientific manner than in the past.

The final chapters on colour and light-projection include a variety of special applications of light such as motor-car headlights, searchlights, flood-lighting, and artificial daylight. (In the calculation of flood-lighting on p. 189 a slip appears to have been made.) The book is concluded by a series of definitions of the chief photometric quantities, a bibliography, and an adequate index.

L'Arc électrique. Par Maurice Leblanc fils. (Recueil des Conférences-Rapports de Documentation sur la Physique. Vol. 3, 1re Série, Conférences 7, 8. Édité par la Société *Journal de Physique*.) Pp. 131. (Paris: Les Presses Universitaires de France, 1922.) 10 francs.

THE first chapter of the work under notice contains the more important formulæ obtained by modern physicists in connexion with the electric arc. A drawback to the use of these formulæ is that it is difficult to find out where theory ends and empiricism begins. If we accept the formulæ we have to abandon the theory of dimensions as applied to equations. In the second chapter Mrs. Ayrton's work is well described. It is stated that Blondel was the first to prove that there was no appreciable counter electromotive force in the arc. If E denotes the potential difference across the arc and I the current through it, then dE/dI is called the resistance of the arc, and it is pointed out that it is a negative quantity. A good description is given of magnetic and mercury vapour lamps. The phenomena shown by the so-called "non-arcing" metals, such as phosphor-bronze, aluminium-bronze, aluminium and zinc, are attributed to a metallic oxide covering the electrodes with an insulating layer or to the vapour being difficult to ionise. It is pointed out that although the current and voltage vanish instantaneously in alternating current arcs, yet their power factor is not unity. This is stated to be due to the fact that they do not both follow the sine law. As a matter of fact, provided that the ordinate of the current wave is always proportional to the ordinate of the voltage wave, and they vanish instantaneously, the power factor would be unity whatever the shape of the voltage wave. The third chapter gives the technical applications of the electric arc to searchlights, furnaces, electric welding, for producing high-frequency waves, and in electric "safety valves" for protection against lightning.

A. R.

Machine-Shop Mathematics. By G. Wentworth, D. E. Smith, and H. D. Harper. (Wentworth-Smith Mathematical Series.) Pp. v+162. (London: Ginn and Co., 1922.) 5s. 6d. net.

THE presentation, in most cases without proof, of a hundred and twenty formulæ in as many pages can scarcely lay claim to the title of mathematics, but this book forms nevertheless a clearly worded and practical introduction to machine-shop calculations. Its scope is confessedly limited to the needs of those who hope to become expert machinists with little or no mathematical grounding, and throughout the book more attention is paid to the explanation of technological details than to the development of method. The use of measuring instruments and calculations affecting cutting speeds, taper turning, screw cutting, indexing and gear cutting are clearly described, generally with the aid of excellent diagrams. The number of formulæ is large, and a judicious reduction in this respect would bring emphasis on to the more important without prejudice to the range of the book. Illustrative problems are worked out in the text, and examples throughout are numerous and well chosen. Their value to the self-dependent student would, however, be greatly enhanced if answers were given. Calculations are in most cases made to cover British as well as American practice, but reference tables at the end give American standards only.

H. W. S.

An Introduction to the Psychology of Religion. By R. H. Thouless. Pp. vi+286. (Cambridge: At the University Press, 1923.) 7s. 6d. net.

THERE is an undoubted movement of thought towards a restatement of religion and religious problems along the lines of recent psychological achievement. This has already taken the place, to a large extent, of the apologetic defence of religion on the plane of the sciences of Nature. Mr. Thouless writes for those who wish to make a study of the problems of religion from a psychological point of view without any prior knowledge of psychological terminology. The most interesting parts of his book are those in which he relates religion to certain of the instinctive tendencies of man, while defending it from the charge of being no more than a subjective experience of gregariousness or sex; and his chapter on the phenomena of mysticism, for which he goes in the main to the mystics of the Roman Catholic Church. He treats this subject with great insight and exactness, and interprets it sympathetically in the light of recent psychoanalytical theory. The book, while avowedly "popular," will be of interest to students both of religion and of psychology.

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.*]

Gravitation and Light-pressure in Nebulæ.

DOES not Prof. Lindemann's theory of spiral nebulæ (discussed by Sir Oliver Lodge in NATURE of May 26, p. 702) fail through disregarding the absorption or reflection of radiation which must necessarily accompany any mechanical action of light-pressure? Prof. Lindemann's typical nebula has a mass of about 0·1 gram per sq. cm. of area, which is probably something like the true value; but to get this value, Prof. Lindemann's assumed particles of diameters 10^{-4} or 10^{-5} cm. must lie behind one another some thousands deep. The particles in the outermost layer are, no doubt, acted on by light-pressure in the way supposed, but not so those in the inner layers; these are shielded from light-pressure but not from gravitation—and here the whole theory seems to fail. Incidentally, a nebula formed of solid particles lying thousands deep would surely be too opaque for novæ formed in its interior to be seen as novæ.

The whole question seems to be governed by a calculation much simpler than any given by Prof. Lindemann. If a star or group of stars emit radiant energy E per unit time, the flow of momentum through any cross-section of a cone of solid angle ω will be $E\omega/4\pi C$ per unit time. Thus the maximum mass m which light-pressure can possibly support (or repel) in this cone at a distance r from the light is given by

$$\frac{\gamma m M}{r^2} = \frac{E\omega}{4\pi C},$$

where γ is the gravitation constant, and M the mass of the star or stars. Thus the maximum mass per unit area, $m/\omega r^2$, is

$$\frac{1}{4\pi\gamma C}\frac{E}{M}.$$

This is of course independent of r, because gravitation and light pressure both fall off as $1/r^2$; it does not depend on the number of stars at work, since E and M are each proportional to that number. For the aggregate of matter in the universe we may perhaps put E/M equal to unity, this being about half its value for our sun. The maximum mass per unit area which light-pressure can support or repel is now $1/4\pi\gamma C$, or about one gram per 25,000 sq. cm., whereas the spiral nebulæ, on Prof. Lindemann's own estimate, have one gram per 10 sq. cm. No doubt it may be argued that the nebulæ in the past were more tenuous than now, but the nebulæ reduced to a surface-density of one gram per 25,000 sq. cm. would cover the heavens many times over at any reasonable distance.

I have long wondered whether a true example of suspension in equilibrium between gravitation and light-pressure may not possibly be found in the shells which constitute the outer surfaces of the planetary nebulæ. That there is suspension in equilibrium seems scarcely open to question; the hypothesis that gravitation and light-pressure are the equilibrating agencies satisfies all the numerical tests I have been able to apply. But it is necessary for stability that the matter should be gaseous, as is in fact spectroscopically found to be the case. A hollow shell of solid particles can be suspended in equilibrium, but this equilibrium cannot be stable for radial displacements. Press the shell closer in to the star and its particles shield one another more from light-pressure, so that gravitation becomes relatively more potent than light-pressure and the shell falls in. But a hollow shell of gas may be stable if its temperature is such that its degrees of dissociation and ionisation are sufficiently sensitive to changes of temperature. Press such a shell closer in to the star and its constituents break up more; assuming that this increases its opacity, light-pressure becomes relatively more potent and the shell is driven back. Draw the shell out to a radius greater than the equilibrium radius and the converse occurs: the equilibrium is stable.

J. H. JEANS.

May 28.

IN the issue of NATURE for May 26, p. 702, there is an interesting letter by Sir Oliver Lodge about a suggestion I had put forward on the nature of the spiral nebulæ. Sir Oliver Lodge suggests that the recombination of electrons ejected photoelectrically might well be more important as a source of light than simple reflection. This does not seem to me probable. In spite of many efforts to improve photoelectric cells, the best type only gives an efficiency of about 2 per cent. Even if the spirals were equally efficient, therefore, only this fraction of the incident energy could be emitted in the form of light on recombination of the electrons. It is probable that any material of which spirals may be composed has a reflection coefficient of at least 20 per cent. and very likely 50 per cent., so that ordinary reflection must be at least ten times and is probably some hundreds of times as effective as the process imagined by Sir Oliver Lodge.

F. A. LINDEMANN.

Clarendon Laboratory,
University Museum, Oxford,
June 4, 1923.

Selection and Segregation.

I THINK by "recent discussions in the columns of NATURE" Prof. Arthur Willey (NATURE, May 5, p. 602) alludes to discussions started by me. I gather that he believes that evolution is founded on mutations the inheritance of which is Mendelian, and, therefore, that natural selection preserves but does not create racial change. Experiment furnishes him with justification, but not with proof. On the same evidence, and a great deal more, divergent opinions have been founded. Crucial tests are required—tests which, from the nature of the case, experiment cannot furnish, but which may be found in abundance among facts that are within common knowledge and are not disputed. So far as I am able to judge, they do not support Mendelian theory, and to them I invite Prof. Willey's attention. If I be mistaken, it should be easy to indicate my errors. If I be right (I am not alluding to Prof. Willey), is it worth while to ignore evidence which is common property and on which attention is more or less riveted, or to hint that I am ignorant of the latest work of the truest biologists—and then to scuttle from my challenge? In spite of Mendelians, the Mendelian facts are so illuminating that they are sure, when linked with the rest of our knowledge, to influence immensely our conceptions of, and control of, life. They can be so linked only by means of crucial instances. May I, therefore, iterate a few of the latter? I have some morals to draw or imply. Can a flaw of fact or reasoning be found in the following?

1. Our powers of observing are proportionate to our familiarity with the objects of study. In all Nature, we are, for purposes of observing fluctuations and natural selection, sufficiently intimate with only one species—our own (see NATURE, January 13, p. 50). Either we must derive our evidence from the lives and deaths of men, or else our thinking is mere guessing. Examining the evidence, we find (*a*) that stringent natural selection is in full swing all the world over; (*b*) that fluctuations, not mutations, are chosen; and (*c*) that the result is always adaptive evolution. If that be the case with men, whom naturalists describe as having "escaped from selection," is it not, to say the least, likely to be the case with other types?

2. Human races never differentiate while there is interbreeding, but invariably diverge when separated by time and space. So far as clear evidence goes, this is true of all natural types. Have we not here proof that offspring blend parental differences, and therefore that natural racial change is based on fluctuations?

3. It has been said very truly, "The fact that the gametes of the cross transmit each member of the pair pure, is as strong an indication as can be desired of the discontinuity between them." The converse must be true also; if the members of the cross blend, we have proof that the unlikeness between them was built up of fluctuations. Now, all human races, and so far as I know all natural races, blend when crossed, except in characters linked with sex.

4. There is massive evidence, not disputed by Mendelians, that male is undeveloped female, and *vice versa*. Here we have alternate patency and latency, alternate *reproduction*, *not* alternate *inheritance*. Male and female characters, belonging to different sets, do not blend; but, presumably, *the patent characters of the one sex blend with the latent characters of the other*. Sometimes, as in aphides, the patency and latency extends unaltered over many generations. But if, as is alleged, the *inheritance* of sex is Mendelian and segregation occurs, how is the prolonged latency of the male traits conceivable? Theoretically males, as well as females, should appear in the first parthenogenetic generation, after which, since the males cannot reproduce, and the females have become pure dominants, males should never again appear.

5. If a mutant crosses with the normal, we have, admittedly, in the impure dominant, exactly such patency and latency as is found in sexual characters. Mendelians insist that afterwards there is segregation, and, therefore, that in following generations pure dominants and recessives occur. How, then, does it happen that "pure" dominants sometimes produce recessives, and recessives dominants? How does it happen that *purely* bred domesticated types (*e.g.* pigeons, poultry, and many plants) often "throw back"—reproduce the ancestral type which according to theory was eliminated perhaps hundreds, perhaps even thousands, of generations previously? Is this not clear evidence that Nature treats mutations like sexual traits, making their reproduction, not their inheritance, alternate?

6. Crossing often reveals long-lost ancestral traits among artificial varieties, but never among men or other natural types. Is this not clear proof that while man often chooses mutations, Nature selects among fluctuations? But man does not always choose mutations. Sometimes, though he cannot easily perceive fluctuations except among his own kind, he selects them. Thus speed in racehorses is due to a high average of excellence in a thousand co-ordinated structures. A thousand mutations occurring at once are out of the question. As might be expected, (*a*) racehorses tend, in lack of stringent selection, to retrogress with a speed which is proportionate to the antecedent progression, and (*b*) the offspring of a cross between race and ordinary horses blend the parental differences, as in hunters and hacks.

7. Apparently, then, the crossing of mutants with the normal results in alternate reproduction. Yet careful artificial breeding produces all the effects of alternate inheritance; for in this way undesired traits may be rendered almost permanently latent, as witness the narrow stripes revealed by the offspring of horses crossed with the broad-striped Burchell zebra, whence it appears that man never domesticated the horse as such, but began with an animal striped like the Somali zebra, the coloration of which he rendered latent by selecting mutations. Human mutations—idiocy, hare-lip, tumours, and so on—are common; but useful human mutations are unknown. Many of them, idiocy, for example, become yearly more common, and medical men, believing that they usually indicate the reappearance of latent ancestral traits, hope by preventing procreation to reduce their frequency. If, however, Mendelian theory be correct, they are new variations, and the position of humanity is hopeless. In that case the human species is "ever-mutating"; and, since human mutations are ever-injurious, there is no scope for selection. And yet the odd thing is that there is always selection, and the result is always improved adaptation.

8. I suppose my word "predisposition" (potentiality, diathesis) corresponds somewhat with the Mendelian word "gene." But I merely follow physiologists and pathologists who, assuming germinal predisposition, seek in each case to discover the nurture that causes development. If I have speculated, it is only to suppose, as others have done, that perhaps all the cells of the body are alike in nature, and differ only through nurture. "Gene," on the other hand, implies a knowledge more profound, or an assumption more daring. Itself a discrete unit, it is the representative of a unit character (one with Mendelian inheritance). Like the "physiological units," "gemmules," and "determinants" of our predecessors, it is a brick in the architecture of the germplasm. It is difficult to understand, however; for the multicellular individual, a cell-community, is compounded of characters; and a character may be a sub-community (*e.g.* rose-comb, extra digit, blacksmith's muscle), or a quality of the whole community (for example, size, shape, colour), or a quality of a character (for example, colour of a flower). As we have just seen, crossed natural varieties blend their characters: have they, then, no unit characters, and, therefore, no genes? I understand that characters, not their modifications, are represented by genes. Thus there is a gene (or genes) for normal but not for diseased skin, for skin-colour but not for sunburn, for normal but not for blacksmith's muscles. Unfortunately I know of no character that is not a modification of its antecedent self. Thus the muscles of the athlete were modified by nurture from those of the ordinary man, which were modified from those of the youth, and so on right back to the germ-cell. Which, then, is the character, and which its modifications? *Obviously* all characters are "fluctuations due to conditions of environment, to nutrition, correlation of organs, and the like. There is no indisputable evidence that they can be worked up and fixed as a specific character." But try to conceive a character which is not a product of some sort of nurture! It appears, then, that genes represent nothing conceivable, and that evolution is impossible. But the attempt to understand genes makes my head

ache. Intellectually unfit to grapple with these subtilties, I must return to the simple, if crude and ignorant, physiological conception that all characters are products of germinal predisposition and somatic nurture; and to the notion that, while there is always blending and sometimes alternate reproduction, there is never alternate inheritance.

G. ARCHDALL REID.

20 Lennox Road, South, Southsea, Hants,
May 17.

Martini's Equations for the Epidemiology of Immunising Diseases.

THE differential equations constructed by Dr. Martini and quoted by Dr. Lotka in NATURE of May 12, p. 633, namely,

$$\frac{du}{dt}=\alpha u(1-i)-qu, \quad . \quad . \quad . \quad (1)$$

$$\frac{di}{dt}=\alpha u(1-i)-mu, \quad . \quad . \quad . \quad (2)$$

aroused my interest by the statement that they cannot be integrated in finite terms. I have noticed that in one particular case the integrals of the equations can be expressed in a moderately simple form, and that in this case Dr. Martini's second position of equilibrium, namely,

$$u=\frac{m(\alpha-q)}{\alpha q}, \quad i=\frac{\alpha-q}{\alpha},$$

is unattainable within a finite time unless it is permanent.

The particular case in question which has come to my notice is that in which $q=m$, that is to say, the fraction of the affected population which ceases to be so per unit time is equal to the fraction of the immune population which loses immunity or dies per unit time. In this case it is evident by subtraction that

$$\frac{du}{dt}-\frac{di}{dt}=-q(u-i),$$

so that $u-i=Aqe^{-qt}$, where A is the constant of integration. On substituting for i in (1) it is evident that

$$\frac{du}{dt}=(\alpha-q+\alpha Aqe^{-qt})u-\alpha u^2,$$

an equation reducible to the linear form (and so soluble by quadratures) by the substitution $v=1/u$.

The solution, which it will be sufficient to quote, is

$$\frac{1}{u}=\sum_{n=0}^{\infty}\frac{(-)^n\alpha^{n+1}A^n e^{-nqt}}{(\alpha-q)(\alpha-2q)\ .\ .\ .\ (\alpha-nq-q)}$$
$$+B\,exp\{(q-\alpha)t+\alpha Ae^{-qt}\},$$

where B is the second constant of integration.

It is easy to see that the second position of equilibrium is given in this case by

$$u=i=\frac{\alpha-q}{\alpha},$$

and if u and i have this value for a finite value of t, it is readily seen successively that $A=0$ and $B=0$, so that u and i have this value for all time. On the other hand, whatever be the values of A and B, the value $(\alpha-q)/\alpha$ is the limit to which both u and i tend as the time tends to infinity, provided that α exceeds q; if α does not exceed q, they tend to zero, unless $B=0$.

I imagine from Dr. Lotka's silence concerning these results that they have not been previously obtained, and, for all I know, the case $q=m$ may be of no practical importance. But the analysis which I have given seems to me to throw some light on what the behaviour of the solution might be expected to be in the general case.

G. N. WATSON.

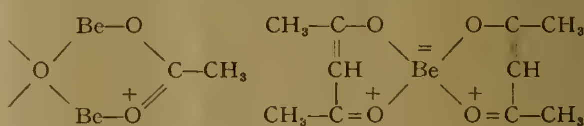
The University, Birmingham,
May 12.

The Structure of Basic Beryllium Acetate.

THE remarkable compound $Be_4O(C_2H_3O_2)_6$, the crystal structure of which Sir William Bragg describes in his letter in NATURE of April 21, p. 532, can be given a chemical formula in complete accordance with its properties. Tanatar and Kurowski have described (Journ. Russ. Phys.-Chem. Ges. 39, 936, 1630; 40, 787; *Chem. Centr.* 1908, I. 102, 1523; II. 1409) a series of compounds (including the formate, acetate, propionate, and benzoate) of the general formula Be_4OA_6. These compounds have none of the characteristics of salts. They are volatile, they have low melting-points (some are liquid), they are soluble in organic solvents such as benzene, and they do not conduct electricity.

They resemble the non-ionised members of the "chelate" series of compounds, to which Prof. Morgan has directed attention. These are derived from substances containing such groupings as HO – C. . . . . C = O, which combine with an atom of a metal by replacement of the hydroxyl hydrogen, and at the same time also (as he has shown) through the carbonyl oxygen. The simplest example is the volatile beryllium acetylacetonate (formula I.). The carbonyl oxygens becoming trivalent must each lose an electron. These two electrons go to the beryllium, which already has two valency electrons, and thus give it the four required to constitute the four non-polar links in the resulting compound. Chelate compounds of this type, in which the group is attached through both oxygens to the same metallic atom, are not formed by the carboxyl group, obviously because this would lead to the formation of a 4-ring, which is unstable. But there is no reason why the carboxyl should not react in this way if the attachment is to two different metallic atoms, with the formation of a ring of 5 or 6 atoms.

This must happen with basic beryllium acetate. We have at the centre, as Sir William Bragg suggests, the oxygen atom attached to 4 beryllium atoms. The octet of the oxygen is made up of 4 electrons from the four beryllium atoms, and four from the oxygen. But the oxygen atom originally had six valency electrons, and so it must lose two. The attachment of the acetate group to two beryllium atoms is shown in formula II. It forms a 6-ring:—



II. I.

But in forming the ring each acetate group must lose an electron from its carbonyl oxygen, so that the six give up six electrons, in addition to the two given up by the central oxygen. We therefore have eight electrons, two of which go to each beryllium atom, increasing its valency electrons from 2 to 4. Thus each beryllium atom can form four non-polar links, these being (1) to the central oxygen, and (2, 3, 4) through three acetate groups to each of the other three beryllium atoms. One of these six chelate groups thus corresponds to each edge of the tetrahedron.

Mr. T. V. Barker has pointed out to me that if the double link in the carboxyl group remains permanently attached to one particular oxygen atom, the most symmetrical configuration of the molecule is one that exhibits a threefold axis of symmetry, and consequently is enantiomorphous; but if the double link oscillates between the two oxygens, then the symmetry is that of a regular tetrahedron.

Tanatar and Kurowski have described (*l.c.*) a compound $Zr_4O_5(OCO{\cdot}C_6H_5)_6$, which is soluble in benzene. Now zirconium can form 6 non-polar links, and in the group Zr:O two of these form the double link to the oxygen, which also absorbs two of the 4 zirconium valency electrons. Thus the group ZrO resembles a beryllium atom in having two free valency electrons, and also the power of forming four non-polar links. The zirconium compound can therefore be formulated as $(ZrO)_4O(OCO{\cdot}C_6H_5)_6$, with a structure exactly analogous to that of the beryllium compound. It would be interesting to know whether this zirconium benzoate has, as one would expect, a crystal structure similar to that of the basic beryllium acetate.

N. V. SIDGWICK.

Dyson Perrins Laboratory, Oxford, May 15.

Biology of Man.

IN the review by J. S. H. of Mr. Wells's "Men Like Gods" (NATURE, May 5, p. 591) we are told that even domestic-minded leopards and tigers are not lightly to be dismissed after recent experiments on the *inheritance* of tameness and wildness in rats. Almost in the next paragraph we are further informed that the rôle of eugenics is to be reduced to a minimum, and its functions are to be replaced by education. Wildness in the lower animals is to be removed by selective breeding, wildness and brutality in man is to be cured by education, by environment, and that mysterious process a "change of heart." It is very strange how dominant is the wholly unwarranted belief that man is an animal for whom other laws hold than for his humbler mammalian kindred.

KARL PEARSON.

Galton Laboratory of National Eugenics,
University of London.

IN referring to the reduction of eugenics to a minimum I was quoting Mr. Wells, not putting forward my own views. Later on, in criticising Mr. Wells, I expressly referred to the possibility of the "control of heredity" in man as well as in lower organisms.

In the second part of his letter Prof. Pearson is ambiguous. He refers to "the wholly unwarranted belief that man is an animal for whom other laws hold than for his humbler mammalian kindred." In one sense of the word *other* this is of course wholly unwarranted—if, that is, we take it to mean "wholly different." If, however, we mean that, besides the laws applicable to lower organisms, there are "other" *additional* laws at work in the sphere of human evolution, then I venture to say that we are enunciating a truism. To take the simplest and most important example. No other organism can transmit tradition for more than one generation: man can. Or to take another example cognate to the "change of heart" (which need be no less important for being "mysterious"), you do not find cows or sheep or other of man's mammalian kindred stopping the business of their existence to look at the sunset or at a work of art; whereas man (or rather many men) do so.

One of the chief human characters of man is his greater modifiability (in the strict biological sense). This implies that alteration of environment, especially of social environment, must co-operate with eugenics if any human progress is to be achieved. J. S. H.

Official List of Fourteen Generic Names of Fishes.

THE Secretary of the International Commission on Zoological Nomenclature has the honour to notify zoologists, especially ichthyologists, that Prof. David Starr Jordan and the U.S. Fish Commission concur in recommending the adoption of the general principle that names now current are not to be discarded unless the data show this to be a clear-cut necessity. Under this general principle they propose that the following fourteen generic names of fishes, in regard to which a difference of opinion exists, shall be provisionally legitimised with the types indicated:

Aëtobatus Blainv., 1816 (type, *Raja narinari* Euphrasen); *Conger* Cuv., 1817 (*Muraena conger* L.); *Coregonus* Linn., 1758 (*Salmo lavaretus* L.); *Eleotris* Bloch and Schneider, 1801 (*gyrinus* Cuv. and Val.); *Epinephelus* Bloch, 1792 (*marginalis* Bloch); *Gymnothorax* Bloch, 1795 (*recticularis* Bloch); *Lampetra* Gray, 1851 (*Petromyzon fluviatilis* L.); *Malapterurus* Lacépède, 1803 (*Silurus electricus* L.); *Mustelus* Linck, 1790 (*Squalus mustelus* L. [= *Mustelus laevis*]); *Polynemus* Linn., 1758 (*paradisaeus* L.); *Sciaena* Linn., 1758 (*umbra* L. = *Cheilodipterus aquila* Lacép. as restr. by Cuvier, 1815); *Serranus* Cuv. (*Perca cabrilla* L.); *Stolephorus* Lacép., 1803 (*commersonianus* Lacép.); *Teuthis* Linn., 1766 (*javus* L.).

The Secretary of the Commission will delay the vote on this case until one year from date, in order to give to the profession ample opportunity to express concurrence or dissension as respects any or all of these names.

C. W. STILES,
Secretary to Commission.

25th and E. Streets, N.W.,
Washington, D.C., May 10.

Tertiary Brachiopods from Japan.

WITH reference to the notice of Ichirô Hayasaka's memoir on "Tertiary Brachiopods from Japan" in NATURE of May 12, p. 647, may I add my testimony as to the extreme importance of this work, and, at the same time, direct attention to one or two discrepancies? To do full justice to this memoir is beyond the scope of this letter, and one can only deal with the matter in the briefest possible way.

Mr. Hayasaka is to be congratulated upon having provided us with such an excellent list of Japanese Tertiary Brachiopoda, many of which seem to be correctly placed as to genus and species. There are some forms, however, which one is surprised to find included in the list, for example, *Hemithyris psittacea*, *Terebratulina caput-serpentis*, *T. septentrionalis*, *Magellania* (*Neothyris*) *lenticularis*, and *Magadina cumingi*.

With regard to *H. psittacea*, considering its wide circumpolar distribution, it might reasonably be expected to occur as an Upper Tertiary fossil in Japan; but the figures given by Hayasaka do not suggest this species to me. They show a much larger shell, without the characteristic beak.

Terebratulina caput-serpentis (now *retusa*) is North Atlantic in its distribution, and a variety (*v. emarginata*) inhabits the Mediterranean. It ranges from the Miocene in Europe.

Terebratulina septentrionalis is also a North Atlantic species, occurring on both the American and North European shores. The geological history of this species is not well known; but it is cited from the Pliocene. I am dealing with its supposed occurrence at the Cape in a forthcoming paper.

The presence of the essentially Austral forms, *Magellania lenticularis* and *Magadina cumingi*, in the Tertiary rocks of Japan, opens up a very wide question as to the former geographical distribution of these genera. With regard to the first species, I might point out that the figures accompanying the memoir do not suggest the New Zealand form; figure 17 especially being very unlike.

As to *Magadina cumingi*, the figures certainly present a general resemblance to the species occurring off the coasts of S.E. Australia and to certain New Zealand Miocene forms. But identity in outward appearance is not a safe criterion. It is found by experience that it is necessary to investigate the interiors before a species can be definitely referred to its proper genus. Forms having the same shape externally may possess quite different loop-stages. This feature is nowhere better displayed than in the forms possessing Bouchardiform beak characters, like the species in question.

In conclusion I should like to point out that Dall's generic name for *T. grayi* Reeve, namely, *Pereudesia*, 1920, is antedated by my *Coptothyris*, 1918 (replacing my *Thomsonia*, 1916, preoccupied). This fact has been pointed out in other papers. By the recognition of this form as a distinct genus there are now three finished types of northern genera in the Dallininæ.

J. Wilfrid Jackson.

Manchester Museum,
May 21.

The Ionising Potentials of Nitrogen and Hydrogen.

In a paper published last autumn (Proc. Roy. Soc. A, 102, pp. 283-293, 1922) I suggested a new mode of attack on some ionisation problems and described its application in experiments on mercury vapour. The object of the method is to give a direct means of studying the types of ion produced in a gas or vapour by the impact of electrons of known speed. The experimental principle involved is the combination of an ordinary ionising potential arrangement with a simple positive-ray analysis apparatus. The extension of the method to gases and some of the results obtained may be of interest.

For the production of ions the common arrangement of a tungsten filament, a grid and a plate is used. Electrons from the filament are accelerated to the grid by a field V_1 and then retarded by an opposing field V_2 which also serves to draw positive ions toward the plate. A narrow slit in this lets through a beam of positive ions which are then further accelerated by a large electric field, V_3. These ions are then bent in a semicircle by a magnetic field and detected electrically. Different values of V_3 bring ions of different m/e on to the detecting slit. By using two Langmuir pumps a sufficiently high vacuum is maintained in the positive ray box to prevent scattering, and very sharp peaks are obtained corresponding to different types of ion.

In nitrogen it was found that for values of V_1 slightly above the ionising potential of 16·9 volts, only molecular ions of $m/e=28$ were present. As V_1 was increased small numbers of N^{++} ions began to appear at 24·1 ± 1·0 volts, while N^+ ions were not present in appreciable numbers until V_1 passed 27·7 ± 1·0. These three critical potentials are interpreted as corresponding to the transitions $N_2 \rightarrow N_2^+ + e^-$, $N_2 \rightarrow N^{++} + N + 2e^-$ and $N_2 \rightarrow 2N^+ + 2e^-$. If this interpretation is correct, the first ionising potential of atomic nitrogen is about 11 volts and the second about 18 volts, assuming the heat of dissociation of nitrogen to be of the order of 140,000 calories, equivalent to six volts.

At a value of V_1 corresponding to the K-limit for nitrogen (375 volts) the proportion of atomic ions increased very sharply.

Preliminary results on hydrogen indicate that the ionisation of molecular hydrogen in the neighbourhood of 16·5 volts is not usually accompanied by dissociation as has been generally supposed. Whether there may be a small number of atomic ions produced at this point is not yet certain. Experiments are being continued.

H. D. Smyth.

Cavendish Laboratory,
May 25.

Chromosome Numbers in Aegilops.

I have recently been investigating the cytology of species of Aegilops, and find the chromosome numbers as follows:—

	Haploid Number.
Aegilops cylindrica	= 7
A. ovata	= 14
A. ventricosa	= 14

On morphological and other grounds I expressed the view in my monograph on "The Wheat Plant" that one or both of the former species appear to be involved in the ancestry of the *vulgare* group of wheats. Later I hope to discuss the significance of these chromosome numbers in relation to this hypothesis.

John Percival.

University College, Reading,
May 26.

Effect of Insulin upon Blood Sugar Concentration.

The injection of insulin into rabbits causes the blood sugar concentration to be lowered, as determined by micro methods. When a certain concentration is reached, 0·05 per cent. by Bang's method, the animal goes into convulsions. If the animal is then killed and the sugar extracted from a large quantity of blood, it is found that it is without copper-reducing value as determined by the Wood-Ost method. This method is not liable to estimate substances in blood other than reducing sugars.

There is, however, a considerable quantity of carbohydrate present, as indicated by the α-naphthol test. The substance is dextro-rotatory. We have not succeeded by acid hydrolysis in obtaining copper-reducing substances from it, though these can apparently be formed under certain conditions as a result of enzyme action *in vitro*.

Dudley and Marrian (Proc. Physiol. Soc., May 19, 1923) have shown that the glycogen content of the liver and muscles of animals is greatly diminished after insulin. We have obtained from the liver and muscles of rabbits after insulin a substance similar to that present in blood under this condition. Owing to its resistance to acid hydrolysis it would not be estimated by ordinary methods. The chemical nature of this sugar is being studied.

We noticed in the case of some solid preparations that the α-naphthol reaction gradually disappeared on drying. Mr. H. F. Holden suggested that this might be due to polymerisation, and that on hydrolysis with acid the α-naphthol reaction would reappear. We find that this happens. It seems possible that the carbohydrate content of the animal body may be not appreciably diminished after large doses of insulin. The above facts would suggest that the sugar stored in the body as glycogen is converted into this peculiar form. Can this be the "Zwischen-kohlenhydrate" which Laquer suggests is formed as an essential step in carbohydrate metabolism?

L. B. WINTER.
W. SMITH.
Biochemical Laboratory, Cambridge,
June 4.

The Value of the Planck Constant h.

IN NATURE for March 3, p. 287, I directed attention to the desirability of obtaining new data on the value of e/m, from deflexion experiments or from the Zeeman effect.

Dr. Harold D. Babcock, of the Mt. Wilson Observatory, has just finished a series of measurements on the value of e/m, from the Zeeman effect, and obtains as the weighted mean of 49 separate determinations, a value of $1{\cdot}761 \times 10^7$, as compared with my recomputed value of $1{\cdot}758 + 0{\cdot}009$ from spectroscopic data. A thorough study of possible errors leads Dr. Babcock to the conclusion that the error in the above value can scarcely exceed $\pm 0{\cdot}002$. On this basis Dr. Babcock's new value of e/m is the most accurate now known.

Particular interest attaches to the value of the Planck constant h, using this new value of e/m. Of the seven methods listed by the author in his determination of the most probable value of h (*Phys. Rev.*, 14, 361, 1919), the only method involving the value of e/m is that from Bohr's theory of the Rydberg constant N_∞. Using for the sake of technical accuracy the value of $N_\infty (= 109{,}737)$ and the assumed value of $e/m = 1{\cdot}761 \pm 0{\cdot}002$, we obtain $h = 6{\cdot}556 \pm 0{\cdot}011$ instead of $6{\cdot}542 \pm 0{\cdot}011$, using $1{\cdot}773 \pm 0{\cdot}002$ for the value of e/m. This latter value of e/m and its error were obtained from the results given in Kaye and Laby's Tables. It is now evident that the close agreement in the mean value of e/m, from Zeeman effect and from deflexion experiments, given in those tables, is merely an accident, and that the author's previous assumption of error in e/m was unjustifiably small.

The new value of h is not only in very close agreement with my previous most probable value (6·5543), but coincides exactly with Duane's latest value, from the continuous X-ray spectrum. Using these two new values of h (methods 3 and 4 of the article cited), we obtain as a corrected most probable value $h = 6{\cdot}557 \times 10^{-27}$ erg. sec. I believe that the error in this quantity can be scarcely more than a few units in the last place, unless Millikan's value of e is unexpectedly in error.

RAYMOND T. BIRGE.
University of California,
May 18.

A Method of Broadcasting Pictures.

I HAD occasion to suggest to the British Broadcasting Co. a few weeks ago that an attempt should be made to "broadcast" a picture, and proposed a simple method of doing so. The company thereupon invited me to try the experiment on Empire Day (May 24). A photograph of H.M. King George V. was chosen as a suitable subject, and it was broadcast at 5.45 P.M. in 20 minutes, and instructions were given for reproducing the picture, either in typescript or in graduated dots on squared paper.

Most of the pictures show an unmistakable likeness. The best versions were sent in by Gladys Haylock, Queen's Park, London, and Reginald Matthews, King's Lynn. The former, who is 11 years old, states that the reproduction was made in three-quarters of an hour. The B.B.C. has decided, as a reward, to broadcast the portraits of these children in turn.

The method is, briefly, the following: The picture is divided into a number of small squares, and the average brightness of each square is indicated by one of six letters. The estimation is made by any photometric method, but a little practice soon teaches one to estimate it by mere inspection. The six letters are chosen so that the spaces taken up by them in typewriting have different average shadings forming a scale of darkness which corresponds to the average shading of the squares represented by the letters. Another consideration in this choice is the ease of telephonic transmission. The letters X, I, J, G, M differ sufficiently in pronunciation to be unmistakable, and the last four have increasing darknesses when typed; X represents a note of exclamation. The lightest space is indicated by a full stop, dictated as "stop." A blank is indicated by the vowel sound O.

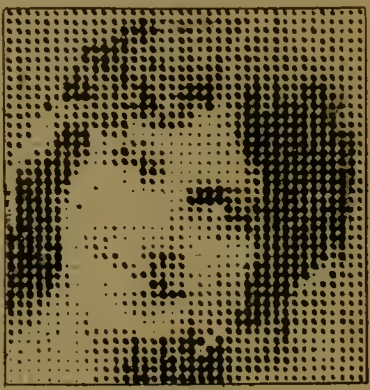


FIG. 1.

Fig. 1 shows a picture consisting of 1520 dots. It is a reproduction of a half-tone picture only 8 mm. wide which I "coded" with the aid of a special microscope kindly lent to me by Prof. R. R. Gates. The number of dots used is somewhat large.

For the Empire Day experiment it was necessary to have a smaller number of dots, so as not to exhaust the patience of the recipients. The result of limiting a picture to 600 dots is seen in Fig. 2.

Each line contains 20 dots. The letters representing these are dictated in fives, thus:

(1) . . . . g j j j j j g . . . .
(2) . . . . g m g j x g j j g g . . .

and so on.

The quickest method of reproduction is to use a special typewriter having six letter keys, each connected with a lever printing a dot of the corresponding size. A simple photographic method with two discontinuous movements might also be used, in which case we might obtain a negative for subsequent multiplication.

Coloured reproductions have also been suggested, but no doubt the chief advantage of the method will be found in its extreme simplicity.

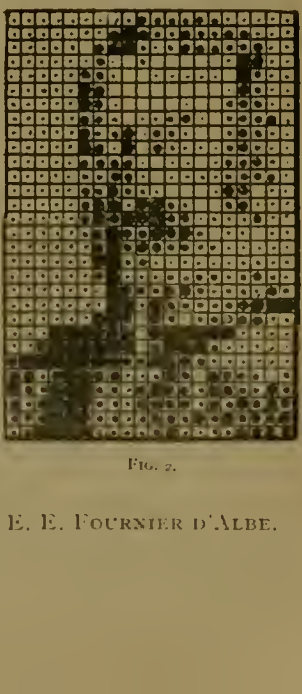


FIG. 2.

E. E. FOURNIER D'ALBE.
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Hay Fever.

HAY fever is a catarrhal affection mainly of the upper respiratory passages, which occurs only in certain individuals and is due to the poisonous action of the pollen of certain plants which they have inhaled. Our knowledge of the disease may be divided into three periods, viz. clinical, experimental, and therapeutic. The clinical period was inaugurated by John Bostock, the physiologist, in 1819. He gave an admirable account of the symptoms as they occurred in himself every summer over a period of thirty-eight years. Other accounts, complete and incomplete, gradually accumulated, and these were analysed with great discrimination and acumen by Phoebus of Giessen, who published his work "Der typische Früh-sommer-Katarrh" in 1862. Nothing has been added to the pure clinical history of the disease since this time. The second period is typified by the masterly scientific research of Dr. Charles H. Blackley, of Manchester, who was also a sufferer from the disease. In his work "Experimental Researches on the Causes and Nature of Catarrhus aetivus," 1873, he established, by ingenious methods, the fact that hay fever is caused by the inhalation of pollen. To this period belong also the works of W. P. Dunbar, of Hamburg. He also was a hay-fever sufferer. Going beyond Blackley, he proved that it is only the protein of the pollen that is the toxic agent. The third period, in which fall attempts to prevent or cure the disease by specific means, is associated particularly with the names of Noon and Freeman in England and Dunbar in Germany.

It was in 1819 that the disease was made known by Bostock, who described the symptoms from which he suffered every June and July almost all his life. These symptoms were, a sensation of heat in the eyes with itching and smarting. After about a week, violent sneezing occurred, with a feeling of tightness in the chest, difficulty of breathing, languor, and loss of appetite. Towards the end of July, all this discomfort spontaneously disappeared. It is remarkable that medical history contains only one or two trivial and doubtful references to such a condition before the appearance of Bostock's paper in 1819. In 1828 he made a second communication and included statements of twenty-eight cases like his own. All developed the disease at the same time of the year—the summer, and nothing special could be ascertained as to its cause from the age, sex, constitution, or mode of life of the sufferers, who were mostly males.

In this second paper Bostock referred, however, to the idea, apparently prevalent even at that time, that the morbid state was engendered by effluvia from new-mown hay, but he was not of this opinion from observations on himself, both at Ramsgate, where there was no hay, and at Kew, where there was much. He considered that the main factors which led to an outbreak were dazzling sunlight and excessive summer heat. Even in 1828, however, MacCulloch refers to the "term hay-fever lately become fashionable"; and William Gordon, writing in 1829 on the "nature, cause, and treatment of hay asthma," said that there could be no doubt that it was due to the aroma emitted from the flowers of grass, particularly from those of *Anthoxanthum odoratum* or sweet-scented vernal grass. He based this view on the grounds that (1) the plant is one of the most strong scented of the grasses; (2) because as soon as it begins to flower, and *not until then*, the asthma begins; (3) because as the flowers arrive at perfection the disease increases; and lastly, because after the flowers have died away previous sufferers can pass through the most luxurious meadows with impunity.

After the accounts of Bostock and Gordon, cases began to be published, and all the authors were of opinion that the disease occurred in certain persons who were presumed to have a predisposition to it, and it was early recognised, especially by Elliotson (1833), that inheritance plays a part in the idiosyncrasy, a belief that all later observation has confirmed. Of 59 histories analysed by Phoebus, 23 occurred alone in their respective families, whereas 36 were associated with one or more other families. The whole of the latter occurred in 13 families, being distributed as follows: in 8 families 2 affected (brothers and (or) sisters); in 5 cases father and child. In 2 families 3 members were affected; in 1 family 4 members, and 2 families 5 members. In one of the latter, a man, his daughter, and three sons suffered, while a fourth son was made asthmatic by the smell of guinea-pigs. The disease was known to be commonest among the better classes, and many of those who have written on the subject were themselves attacked. Among these may be mentioned Bostock, Blackley, Gream, Kirkman, Fleury, Helmholtz (the physicist), Dunbar (the bacteriologist), and Verworn (the physiologist). Among 150 cases collected by Phoebus 100 were male and 50 female.

Although it was early suggested that the origin of the symptoms was referable to vernal grass in flower, there were authors whose experience did not permit of such an exact diagnosis. Some thought that grasses were all equally detrimental, others that only aromatic grasses were the agents, and particularly *Anthoxanthum odoratum*. Others again blamed rye-grass, hay as such, roses, trees in bloom, dust, sunlight, heat, and even bacteria. The last was the view of Helmholtz. Even where grasses were incriminated it was believed that the actual cause was some aromatic effluvium wafted from the plant. Some believed that the chief agent was coumarin. Kirkman (1852) seems to have been the first who tested upon himself the effect of pollen. At Christmas he noticed in his hot-house a single plant of *Anthoxanthum odoratum* in blossom and laden with pollen. He plucked it, rubbed the pollen with his hand and sniffed it up. Almost immediately sneezing and all the symptoms of an attack of hay fever followed.

It was, however, Charles Blackley who, in a series of experiments well conceived and admirably carried out over a long series of years, definitely established the pollen etiology of the disease. Having obtained negative results with benzoic acid, coumarin, odoriferous substances, ozone, dust, light, and heat, he applied himself to the subject of pollen, not of grasses only but from plants belonging to no less than thirty-five other natural orders. The experiments were made at all times of the year, the pollen being applied to himself or other patients by way of the nostrils, tongue or conjunctiva, or by inhalation or actual inoculation in the skin—the most approved modern method of diagnosis. Pollen from a number of grasses produced typical hay fever. Blackley particularly blamed the pollen of italian rye-grass (*Lolium italicum*), meadow fox-tail grass (*Alopecurus pratensis*), rye (*Secale cereale*), wheat (Triticum), oats (*Avena sativa*), and the common hazel-nut (*Corylus avellana*). He also studied the size and shape of different pollen grains, and concluded that the disturbance in predisposed persons was due partly to the mechanical and partly to the physiological action. In experiments on himself, dazzling light and heat were ineffective.

To study the distribution of pollen in the atmosphere Blackley then undertook a long series of experiments with ingenious apparatus which he devised, and he traced by microscopic methods of enumeration the pollen grains in the air in a variety of weather conditions. From May to the end of July he traced from day to day the pollen incidence in the air, and showed how it was subject to great fluctuations depending on temperature and moisture. About 95 per cent. of the pollen found was identified as belonging to the Graminaceae. In dwelling-rooms little or no pollen was found. By means of moistened glass slips attached to the tails of kites flown as high as 1500 feet, Blackley made numerous observations both on the sea-shore and inland, and demonstrated the remarkable fact that in the upper strata of the air there was nineteen times as much pollen as was found near the surface of the earth, and he showed how pollen can be carried to great distances by wind currents in the upper reaches of the air.

Blackley was so far ahead of his time, that despite the excellence of his work the causation of hay fever was still regarded as a *terra incognita*. A common idea prevailed that it was a nervous disease in certain persons with a labile or hysterical nervous organisation. The reinvestigation, on the scientific lines laid down by Blackley, led, in the hands of Dunbar (1903), to a complete confirmation of his results; but Dunbar went further by proving that the deleterious agent in pollen is only its protein. Collecting pollen in large quantities, he showed that extracts are highly toxic in hay-fever subjects.

One of Dunbar's collaborators—Liefmann (1904)—found that, at the time of the worst hay-fever attacks in the centre of the city of Hamburg, no less than 250 grass pollen grains settled in 24 hours on a surface measuring 1 square centimetre (*i.e.* about 2,500,000 per square metre). Year by year it was noted that on the first appearance of pollen in the air patients began to suffer from hay fever. In the beginning of June grass pollen is in excess of all others, and from the third week of July begins to disappear. Kammann estimated that 40 per cent. of the pollen mass was protein, and a solution of a strength of 1 : 30,000—1 : 1,000,000 dropped into the eye could determine an immediate attack of hay fever. Dunbar tested the activity of a large number of pollens other than those from grasses, but mostly with negative results. Besides the pollens of grasses and sedges the following pollens were, however, found to be active: honeysuckle (*Lonicera caprifolium*), lily of the valley (*Convallaria majalis*), Solomon's seal (*Polygonatum multiflorum*), evening primrose (*Œnothera biennis*), rape (*Brassica napus*), spinach (*Spinacea oleracea*), as well as a number of Compositæ and privet (*Ligustrum vulgare*). These experiments were all made in Europe. In the United States of America there is a common form of "hay fever" caused not by grass pollen but by pollen of golden rod (Solidago), and particularly ragweed (*Ambrosia elatior*). From its occurrence in September this variety is widely known as "autumnal" or "fall" fever. According to the records of the American Hay Fever Prevention Association, something like 1 per cent. of the whole population (about 1,000,000 cases) are liable to June or autumn fever.

Hay-fever research is being very actively carried out in the States, and already a very large number of pollens are known to be toxic. Several general principles are emerging from this work; for example, the negligible importance of insect-borne pollens as contrasted with the importance of those that are air-borne, and the great variations which occur from the diversity of the local flora. Important hay-fever and botanical surveys are now being compiled from many of the American States. The diagnosis of the capacity of pollen to produce hay fever is made by cutaneous inoculation, by a scratch on the forearm, of a dilution of the pollen protein, which may be extracted in several different ways. A wheal, 5 or more mm. in diameter, surrounded by a red halo and appearing within half an hour, is regarded as a positive reaction.

It is now known that far more plants can produce hay fever than was formerly supposed. Indeed the term "hay fever" is quite inappropriate. "Toxic pollen idiopathy" has been suggested in its place. Later studies have also directed attention to what are called "group reactions." Thus patients with June fever react to grass pollens, while those with autumnal fever react mainly to the pollen of compositæ, such as golden rod, golden glow, sunflower, and ragweed. The group reaction indicates that the pollens of allied families of plants have a common protein chemical constitution. Although many different pollens can produce symptoms, it does not follow that all such pollens are of practical importance in the disease. The principle that only anemophilous pollen is the natural toxic agent is very important, and thus the entomophilous pollens of golden rod, golden glow, sunflower, and daisy, although they can produce hay fever, do not do so in practice except in unusual circumstances. That such circumstances do occasionally operate is made clear by the recent researches of Pott at Bloemfontein. In this city he has clearly shown that a severe form of pollinosis occurs from October to January, and it is caused by the pollen of the pepper tree (*Schinus molle*). Normally this pollen is sticky and is insect-borne, but in the hot, dry weather prevailing in Bloemfontein it becomes dried and is dispersed by wind. In fact, it was the principal and occasionally almost the sole pollen deposited on glass plates exposed to the air, and it was also demonstrated in the nasal mucous secretions of susceptible subjects. Of great importance also is the determination of the actual dates of flowering of hay-fever plants in each particular district. More than 200 plants are known to be capable of setting up symptoms of "hay fever."

With regard to the nature of the predisposition which renders certain persons susceptible to pollen, nothing is known with certainty. It has been suggested that the affected persons may possess a specific proteolytic ferment which, acting on pollen protein, liberates a poison which is the active agent. The predisposition has been regarded as allied to anaphylaxis—the state of hyper sensitivity, which can be induced especially in guinea-pigs by a sub-lethal dose of a protein of some kind.

Hay-fever predisposition, however, differs fundamentally from true anaphylaxis. The anaphylactic state can be transmitted passively to a normal animal by means of the serum of an animal rendered actively anaphylactic. This is not so with hay fever. Dunbar injected the blood serum of hay-fever persons into guinea-pigs, and twenty-four hours later injected the animals intravenously with rye-pollen protein. No positive results were obtained. Further, normal persons never develop hay fever after the subcutaneous injection of pollen protein. Dunbar injected a normal person with quantities of pollen protein far in excess of what he could have received normally, but this individual was able to take long walks through meadows in full flower, with impunity. A normal person has not the capacity of reacting to pollen protein, nor can he be made to develop this power experimentally. It may be said, therefore, that whatever is the nature of pollen idiosyncrasy, it is not to be ranged alongside the true anaphylactic state. It is allied to those idiosyncrasies which occur in certain persons who develop asthma or catarrhal symptoms from exposure to the secretions or excretions of horses, dogs, cats, goats, rabbits, guinea-pigs, or to such substances as silk, or food-stuffs like white of egg, or certain drugs.

From the great mass of persons who have the pollen idiosyncrasy, and the "annual torment," as Blackley called it, which they undergo, it is not surprising that many different treatments have been recommended. If the hay-fever patient could keep away from pollen, naturally he would not suffer from the disease. Thousands of persons find relief annually at the seaside or on islands or barren districts. The German Hay Fever Association used to recommend Heligoland. In the United States, Fire Island on the Atlantic side of Long Island has long enjoyed a reputation as a suitable refuge for hay-fever sufferers. Blackley in England spoke highly of Lundy Island and some of the islands in the Hebrides. For the great majority of patients such luxuries are manifestly impossible.

From the vast number of methods of treatment praised at one time or another, only two are worthy of consideration. Dunbar recommended the serum called Pollantin, prepared by inoculating horses with repeated doses of pollen protein. This is used either in the liquid or dry state for local application to the nose before the onset of symptoms. The main objection to this treatment, which may be most successful in certain cases, is the temporary character of the relief afforded. The other method, erroneously called desensitisation, is the active immunisation of the patient himself by pollen protein introduced by Noon and Freeman. For its success accurate diagnosis of the specific pollen idiosyncrasy is necessary in the first place, the production of strong protein solutions in the second place, and pre-seasonal inoculation in the third place. As the immunity is not durable the treatment must be annual. By this method Freeman (1914) recorded 30 per cent. of complete successes and no improvement in 11 per cent. Between 1916 and 1920 Cooke and Vander Veer injected 1774 patients with complete success in 25 per cent. and no success in 10 per cent. The recent results of Bernton (1923) are of the same order. It is probable that the state of insusceptibility lasts only for a few weeks, when the patient again manifests his idiosyncrasy unaltered.

W. B.

The Tercentenary of Blaise Pascal.

By Prof. H. Wildon Carr.

No one can read the story of Pascal's life without amazement at the greatness of his genius and sadness at the mode in which it found expression. To Voltaire in the eighteenth century he is a "fou sublime, né un siècle trop tôt." To Chateaubriand in the early nineteenth century he is "cet effrayant génie, qui, à cet âge où les autres hommes commencent à peine de naître, ayant achevé de parcourir le cercle des sciences humaines, s'aperçut de leur néant et tourna ses pensées vers la religion." He lived at the beginning of the brilliant leadership of France in the intellectual development of Europe. In his short life he did notable work in mathematics and physics, and above all (to continue the quotation from Chateaubriand), "toujours infirme et souffrant, fixa la langue que parlèrent Bossuet et Racine, donna le modèle de la plus parfaite plaisanterie, comme du raisonnement le plus fort."

To appreciate the greatness of Pascal and to discern the leading motive in his wonderful activity, it is necessary to enter sympathetically into the spirit of the age in which he lived, and particularly to understand the nature of the religious influence which peculiarly affected him from infancy to maturity.

The outward circumstances of his life may be recorded quite briefly. He was born at Clermont in the Auvergne on June 19, 1623. His father, Étienne Pascal, was King's Councillor and Magistrate, president of the *Cour des Aides*. Blaise had two sisters, Gilberte, three years older, and Jacqueline, two years younger than himself. Their mother died when Blaise was three years old. In 1631 the father retired and settled with his family in Paris for the sake of their education. In 1638 he had managed unfortunately to incur the displeasure of Cardinal Richelieu, and, having good reason to fear a *lettre de cachet*, had to go into hiding. He returned home, however, risking arrest, when he heard that his dearly loved daughter Jacqueline was suffering from small-pox, and he remained constantly with her until her recovery. The following year there was brought about a reconciliation with the Cardinal, and shortly after he received the appointment "Intendant pour les tailles de la généralité" at Rouen, to which city the family then went to live. In 1648 the

"Intendants" were suppressed by Mazarin, and the Pascals returned to Paris. The following year they went back to their native Clermont, where Gilberte, who had married her cousin, Florin Périer, was already settled. In 1651 the father died. Blaise, devoted to his sister Jacqueline, had hoped that after the father's death she would continue to make her home with him, but she had already formed her resolution to enter the religious life, and would not be dissuaded from taking immediately the austere vow at the convent of Port Royal.

The four following years are described by Blaise as his "mondaine" period. He sought distraction in travel and society, but in 1655, after a mental crisis which is described as his second conversion, he decided to retire and devote himself entirely to religion. From 1658 till his death in 1662, although not bedridden or incapacitated from attending to his ordinary wants, he was so weak and in such continual pain that he could do no consecutive work. Jacqueline died in 1661. Blaise in his last illness was nursed by Gilberte. He died in her house. When the end was approaching the doctors attending him were assuring him that there was no danger, and refused to call in the priest. Pascal was in anguish lest he should die without the sacrament, but Gilberte acted on her own initiative just in time. She lived to be sixty-seven, and had five children. She wrote the life of her brother, and also a life of her sister Jacqueline.

Blaise Pascal was educated by his father, and had no other tutor. He never entered the university. All his acquaintance with the intellectual movements of his age, with its science, its philosophy, its religion, was derived directly from his father and conversation with his father's friends. On the other hand, at his father's house he met the most distinguished mathematicians and theologians of the time. Étienne Pascal did not merely supervise his son's education; he undertook it alone and unaided in order to follow out a predetermined method, which reminds us, alike in its conception and in its consequences, of the analogous case of the father of John Stuart Mill. One part of the scheme was to concentrate the boy's mind during his earliest years on perfecting his knowledge of his own language. His lessons were limited to the grammar and syntax of his native French, and the teaching even of Latin was deferred until this was acquired, in the expectation that the new task would then be comparatively easy. The other part of the scheme was to defer mathematics, indeed to forbid the study of it, until the acquirement of languages was perfect. The reason of this is curious. The father was not only himself learned in the mathematical sciences, but also had given his daughter Gilberte thorough instruction in them, yet he feared for his son that they would prove of such absorbing interest that he would be distracted from the study of languages. When the lad was twelve, however, the father discovered that he had acquired, apparently surreptitiously, an acquaintance with geometry which amounted to precocity. He was found one day demonstrating for himself with *barres et ronds* the thirty-second proposition of Euclid's first book. We are told that after this he was allowed to read Euclid, but only in his recreation hours.

Not less powerful than the parental influence was that of his sisters. For their education also the father had original ideas. He did not himself undertake it, but they were educated by a man as men. Their tutor was a Monsieur de Mondory, in favour with the Cardinal and the Court. Jacqueline was an extraordinarily precocious child. She was a very pretty girl before the small-pox destroyed her beauty. She wrote verses from the time of her early childhood, and when fourteen composed a comedy in five acts. She was deeply religious. One of her poems is a hymn of gratitude to God for her recovery, and she describes the scars left by the disease as the impressions of God's seal. She no doubt regarded this illness as a sign of her call to the religious life. Soon after her entry to Port Royal she was appointed sub-prioress, and she consulted her superior as to whether she should cultivate her talent for poetry. The reply of Mère Agnes, Arnauld's sister, is pathetic. "C'est un talent dont Dieu ne vous demandera point compte: il faut l'ensevelir." She signed the formulary imposed on Port Royal condemning the Jansenist doctrine under extreme pressure, though she struggled against it and wished to resist. "Je sais bien," she wrote to Dr. Arnauld, "que ce n'est pas à des filles à défendre la vérité, quoique l'on peut dire par une triste rencontre, que, puisque les évêques ont des courages de filles, les filles doivent avoir des courages d'évêques." Arnauld insisted, however, and the grief hastened her death.

To understand the religious fervour of the Pascal family we must also enter sympathetically into the spirit of the age. The seventeenth century shows in all its philosophy, and even we may say in its science, the influence of a deep personal interest in the problem of the relation of the individual mind to God. The reforming zeal of the sixteenth century had spent its force and been succeeded by the universal conviction of the reflecting believer that Christianity is much more than an institution based upon a verifiable historical revelation, that it is, in fact, a revelation in the philosophical meaning, an interpretation of human and divine nature. We only understand Pascal when we see that his religion is not ordinary piety or superstition, but profound philosophy.

Let us now look at the man himself. He is a younger contemporary of Galileo and Descartes. He survived both, but died before Malebranche or Spinoza had begun to write. This is peculiarly significant in appreciating his attitude towards the Cartesian philosophy, for Malebranche developed that doctrine along Augustinian lines, which may have been actually suggested by Pascal's writings. The illustration of *le ciron* to explain the relativity of magnitudes, expounded by Malebranche in the "Recherche de la Vérité," seems taken directly from a well-known passage in Pascal's "Pensées."

Pascal agreed with Descartes in his doctrine of the soul, or thinking substance, with its corollary that the animals are automata, but he was revolted by the "Principia" and its claim to be able to explain the world by "figure and movement." "Quand cela serait vrai," he says, "nous n'estimons pas que toute la philosophie vaille une heure de peine." Notwithstanding his keen enjoyment of mathematical problems and his intense interest in physical experiments, the whole value of philosophy for him lay in the light it shed on moral problems, and on the power it gave man to interpret the Christian revelation. His point of view, while it accepts the principles of Descartes's philosophy, applies them in a way which makes his doctrine its very antithesis.

Descartes was shown the Treatise on Conic Sections which Pascal composed when sixteen, and refused to believe in its originality. He thought it the work of Desargues, from whom indeed Pascal had learnt much, but Desargues himself acknowledged the originality of Pascal's treatise in its essential points. In 1647 Descartes paid two visits to Pascal, who had come to Paris with his sister Jacqueline for medical advice. Jacqueline has given an account of their meeting in a letter to her sister Gilberte Périer. They discussed the question of the void. Torricelli, the pupil of Galileo, had demonstrated the phenomenon of atmospheric pressure by the famous invention of the barometer, inverting a column of mercury in a glass tube closed at one end, with the other end immersed in an open mercury bath, and then measuring the height of the column.

This was of course the crucial experiment, but there still remained considerable doubt as to its interpretation. To many, including Torricelli himself, it was merely a case in point of the old principle that nature abhors a vacuum. Descartes had rejected this principle on *a priori* grounds. Pascal explained to Descartes his theory of an ocean of air, at the bottom of which we were situated, and assumed that like all fluids it would maintain an equilibrium, and reasoned that above every point of the earth's surface was a column pressing down on us, the weight of which would vary with the altitude. He had already made experiments to prove this on a tower in Rouen, and he now proposed to carry out an experiment on a large scale on the Puy de Dôme in Auvergne. Descartes discussed it with great interest and confidently foretold its success. The experiment was carried out by the aid of Pascal's brother-in-law, M. Périer, with the result that the time-honoured, firmly established principle of the abhorrence of a vacuum passed into limbo.

Pascal's life divides naturally into three periods. To the first belong the mathematical works and the physical experiments, to the second the literary achievement of the "Lettres Provinciales," and to the third the philosophical and mystical "Pensées." In all of them his great genius is manifest, and he might easily have been one of those master minds which determine the direction of human thought. In science and philosophy he showed an intellectual power and incentive which places him on a level with Descartes and Galileo, yet he stands alone, grand but solitary, in the great intellectual movement of humanity. It was more than a religious act, it was typical of his whole intellectual position, when he joined the solitaires of Port Royal. We may count his unworldliness as loss or as gain, but he sacrificed for it alike scientific and philosophic leadership. The tragedy is that the Christian Church did not value what he gave to her when he renounced the world.

The works by which Pascal has immortalised himself are "Les Lettres Provinciales" and "Les Pensées." His mathematical works, like his arithmetical machine which took three years to perfect and is preserved at the Conservatoire des Arts et Métiers in Paris, are valuable for the evidence they afford of the nature of his genius rather than for their originality of discovery, but the two great literary works have been read in innumerable successive editions. Yet strangely enough both are valued and cherished for what to Pascal himself was purely adventitious and no part of the original design. The "Provinciales" are classical on account of their attack on the Jesuits and for the exposure of Jesuit casuistry. The world has little interest to-day in the Jansenist doctrine, which it was the main purpose of the letters to expound and to defend. Were it not for Pascal, the very names of Jansenius and Molina would scarcely be known outside narrow theological circles. The doctrine of sufficient grace has little more than antiquarian interest for students, but for Pascal it was the rationalising of Christian doctrine, the philosophy of a religion of redemption as distinct from the institution of sacraments and formularies founded on it.

The "Lettres Provinciales" had an immediate success, but it is unlikely that they would have accomplished their design, or have afforded even a temporary cessation of the Jesuit hostility against the theologians of Port Royal, but for an event of an altogether different nature, and one which had a powerful influence on Pascal himself. This is what is known as the miracle of the sacred thorn. Pascal's niece, Marguérite Périer, was a pensionnaire at Port Royal, and the little girl suffered from an abscess of the lachrymal gland, which discharged into the eye and into the nose, causing her inconvenience and suffering. Medical treatment had proved wholly ineffective, but after having touched the spot one day with the relic of the sacred thorn, exposed for adoration on the altar, she was completely cured. The doctors certified that "la guérison surpassait les forces ordinaires de la nature," and the miracle was solemnly attested by the vicars-general of the Archbishopric of Paris.

"Les Pensées" was not designed by Pascal for publication in any form whatever. When he died a disordered mass of papers containing his written notes was found. They were unconnected, casual, jottings on odd bits of paper, many being incompleted sentences. It was known that Pascal had had in mind to write an "Apology" of Christianity, a defence against atheistical arguments. The editors took this as the clue to the arrangement of the fragments, and Arnauld, Nicole, and other leaders of Port Royal, after the "peace of the church," which restored them to their monastery in 1669, published the first edition of the "Pensées." Few books have had such a success. Edition has followed edition through the succeeding centuries. The original fragmentary notes still exist, and scholars may now study them in the "Reproduction en phototypie du manuscrit des Pensées de Blaise Pascal," published by Monsieur Léon Brunschvicg.

Such was the marvellous genius, the tercentenary of whose birth is being celebrated this year in his native city, Clermont, and at the scene of his activities, Port Royal des Champs, near Paris.

Obituary.

Prof. John Cox.

The death of Prof. John Cox at Hayes Court, Hayes, on May 13, removes an interesting personality from our midst. Prof. Cox devoted an active life to the cause of education and had a varied educational career, holding, at different times, the post of University extension lecturer, headship of a Cambridge college, and a professorship in physics in a Canadian University.

Born in 1851, Cox was a brilliant scholar of the City of London School under Dr. Abbott, where he was a contemporary and competitor for scholastic honours with his friend H. H. Asquith. He went as a scholar to Trinity College, Cambridge, and studied mathematics, being eighth wrangler in 1874. Equally versed in classics, he took a good place in the Classical Tripos of the same year. He gained a fellowship at Trinity College on a dissertation in which he applied Hamilton's methods to some problems in geometrical optics. He was for ten years warden of Cavendish College, Cambridge—a new College offering residential facilities to a younger class of undergraduates at a reduced cost. Ultimately the College was closed down, though some years after Cox had severed his connexion with it.

In 1890 Cox was appointed professor of physics in McGill University, Montreal. Previous to that time the physics had been taught with small facilities by Dr. Johnson, professor of mathematics. This appointment gave Cox a great opportunity, for it was at the time that McGill University was rapidly growing, through the munificent gifts of the late Sir William Macdonald. Ample funds were offered to build a new physics laboratory, and, before making plans, Cox was sent on a mission to study the physical laboratories in Europe and the United States. He threw himself with great energy into the new project, and the result was a well-designed laboratory which at the time of its opening was one of the finest and best equipped in the world. Under the impetus given by the appointment of Callendar and afterwards of Rutherford, the laboratory became a centre of research in physical science, and Cox followed with pride and enthusiasm the pioneer researches of Rutherford and Soddy on radioactivity.

While keenly interested in all developments of physics, Cox had not the practical training requisite for research in experimental physics, but devoted himself to the teaching and administrative side. A fluent and polished speaker, he was an admirable lecturer, and as a speaker for popular audiences on scientific and general topics he had few superiors. It was characteristic of his temperament that he was somewhat dilatory in ordinary business matters and often required the spur of necessity to deal with correspondence. A man of wide interests and wide social sympathies he exercised a strong influence for good both in Montreal and the University. In 1909 he retired from McGill with a Carnegie pension to live in England, and was awarded the honorary degree of LL.D. by McGill University. He immediately took up the work of lecturing for the Oxford Extension Delegacy and particularly for the Gilchrist Trust. This was a type of work which he thoroughly enjoyed and carried out with great enthusiasm and success. During the War, he offered his services to the Ministry of Munitions and assisted in the work of the munition tribunals.

After the death of his wife, Cox lived at Hayes Court with a daughter. He retained his enthusiasm for science to the end and, before his illness became acute, followed with keen interest the work of Einstein and Bohr. Of his publications, the best known is his book on mechanics published by the Cambridge University Press. This useful work was written on novel lines, being largely influenced by the writings of Marx, of whom he was an admirer. Another small book, "Beyond the Atom," gives a vivid account of the bearing of the earlier radioactive researches, with which he had come in contact in Montreal, on the structure of matter. A man of fine character, of attractive personality and varied gifts, his unexpected end will be mourned by a wide circle of friends. He leaves two daughters and a son, who is a mining engineer in Canada.

Mr. R. W. Hooley.

Mr. Reginald William Hooley, whose death on May 5 at the age of fifty-seven we regret to record, devoted many years to the study of the geology of the Isle of Wight, and to the systematic exploration of the Wealden rocks of the south coast. He made an important collection of the remains of reptiles and fishes from the cliffs between Brook and Atherfield, and established a small museum at his residence at Winchester. He also acquired an excellent knowledge of the Wealden reptiles, which he extricated from the hard rock with great skill, and he wrote several important papers on his specimens. He described new Chelonia in the *Geological Magazine* in 1897 and 1900.

In 1904 Mr. Hooley was elected a fellow of the Geological Society, and he contributed papers on unique specimens of the crocodile Goniopholis and the pterodactyl Ornithodesmus to the Society's Quarterly Journal in 1907 and 1913. During recent years he discovered and prepared a skeleton of Iguanodon, in some respects finer than the well-known specimens at Brussels and showing parts of the skin. Of this remarkable fossil he wrote an exhaustive memoir, illustrated by his own drawings, which he had intended to read to the Geological Society at a recent meeting.

Mr. Hooley was an indefatigable worker, with only scanty leisure to devote to science, and his premature death is regretted by the large circle of geologists and palæontologists who enjoyed his friendship and co-operation. His specimens of Goniopholis and Ornithodesmus are already in the Geological Department of the British Museum (Natural History), and the rest of his collection is destined to be added to them.

A. S. W.

We regret that the date of the death of Mr. F. W. Harmer was given incorrectly in Nature of June 9 as April 24: it should have been April 11.

Current Topics and Events.

Some time ago Dr. George Sarton, of the Carnegie Institution, Washington, and editor of *Isis*, directed the attention of scientific men to the enormous amount of ignorance and superstition which still surrounds them (*Isis*, vol. iii. pp. 449-50). This mental condition is not confined to the poor and uneducated, but is to be found among many people who have had the advantage of a collegiate education. Yet how common is that ignorance has recently been shown by the attacks made in the United States upon the Darwinian theory by Mr. W. J. Bryan, a campaign which has found an echo in Great Britain. On May 25 the writer of a letter headed "War on Darwinism" in the *Daily Mail* gravely assured us that *the origin of man has not been discovered by science*, and that the author of the "Origin of Species" was wrong because "Ruskin laughed the thing to scorn in 'The Eagle's Nest,'" and "Disraeli did likewise in 'Tancred.'" That remarkable epistle emanated from a certain "Modern High School, Lee, London." *Damnant quod non intelligunt!* The logic equals the knowledge: Darwin *wrong* because Froude (a manufacturer of English history), Ruskin (a word-painter), and Disraeli (an imaginative writer) laughed and did other things! One would have thought that the days when Darwinism was "reviled by bigots and ridiculed by all the world" were for ever past, were we not forcibly reminded to the contrary by such fanatical attacks from time to time. However man's origin may have been brought about, no trained mind questions the fact of that origin, which is no mere phantasm but rests upon irrefragable evidence. Whether it would be a good thing to teach the doctrines of evolution in our "modern high schools" may be a questionable matter; but it would indeed be a good thing if teachers in "modern high schools" were to teach their pupils to emulate the noble example set them by such scientific men as Charles Darwin and Thomas Henry Huxley, who devoted their lives to the search for scientific truth.

On June 6, at the Langham Hotel, the Anglo-Batavian Society entertained Prof. H. A. Lorentz at a banquet which was attended by a number of British men of science. The Anglo-Batavian Society was formed a few years ago in order to promote good-fellowship between the English and Dutch races, on a similar basis to that of the Pilgrims' Club, which seeks to promote good-fellowship between Great Britain and the United States. A couple of years ago the Society was instrumental in establishing an interchange of University lecturers between Holland and England. At first this was limited to the medical faculty, but last year it was decided to extend the lectures to other faculties, and to include physicists and others. In that way Profs. J. F. Thorpe, Brereton Baker, and Sir Humphry Rolleston visited Holland in the months of February, April, and May last, while Prof. W. de Sitter, of Leyden (astronomy), H. R. Kruyt, of Utrecht (chemistry), E. D. Wiersma, of Groningen (medicine), and Prof. H. A. Lorentz, of Leyden (astronomy and physics), visited Great Britain. During the months of May and June Prof. Lorentz visited consecutively the Universities of London, Manchester, Edinburgh, Leeds, and Liverpool, where he lectured on the rotation of the earth and its influence on optical phenomena and the theory of the Zeeman effect. In addition to these lectures, Prof. Lorentz addressed the Royal Institution on June 1 on the subject of radiation of light, and gave by invitation a series of three lectures at University College, London, on June 4, 5, and 7, on relativity. The last three lectures formed a connected course, the aim being to present in a simple form the fundamental principles and some of the applications of the theory of relativity. The other lectures were mainly devoted to questions belonging to the quantum theory and to a discussion of the relation between it and former views. In his discourse at the Royal Institution Prof. Lorentz showed how the ideas of the corpuscular and the undulatory theory of light were closely interwoven in Newton's mind and may be interwoven once more in the physics of the future. The banquet given to him by the Anglo-Batavian Society was presided over by Sir Walter Townley, chairman of the council of the Society. In replying to the toast of his health Prof. Lorentz expressed his great appreciation of the welcome which he had received everywhere in England.

A representative and well-attended meeting was held on Friday, June 1, at the Royal Society of Medicine, at which it was decided to establish a memorial to the late Prof. A. D. Waller and Mrs. Waller. In view of their lifelong devotion to, and enthusiasm for, scientific investigation, it was felt that the most fitting memorial would be the formation of a fund to be used for the promotion of scientific research. Further, in recognition of their close association with the London (Royal Free Hospital) School of Medicine for Women, where Prof. Waller succeeded Sir Edward Sharpey Schafer as lecturer in physiology, a post which he held from May 1883 to November 1886, and Mrs. Waller was first a student and afterwards a member of council, a position which she held to the last year of her life, it was decided that the research fund should be entrusted to, and administered by, the council of that School. A committee was formed to carry out this scheme, and the following, among others, have consented to serve: Sir E. Sharpey Schafer (chairman), the Maharaj of Jhalawar, Sir Charles Sherrington, Sir Humphry Rolleston, Sir Sydney Russell-Wells, Sir Walter Fletcher, Sir David Ferrier, Sir David Prain, Sir Frederick Mott, Sir Leonard Rogers, Miss Aldrich-Blake, Mrs. Scharlieb, Miss Tuke, Mr. Bousfield, Prof. Adam, Prof. Halliburton, Prof. Gowland Hopkins, Prof. Starling, and Mr. Alfred Palmer. Already 1100*l.* has been promised, and further subscriptions may be sent to the honorary secretaries, Prof. Winifred Cullis and Prof. J. S. Macdonald, or to the hon. treasurer, Prof. J. Mellanby, St. Thomas's Hospital Medical School, London, S.E.1.

A STATEMENT as to the position of the Scientific Expeditionary Research Association was made at a luncheon at the Trocadero Restaurant on June 7. The objects of this Association were referred to in an article published in NATURE of January 13, 1923. It has now been arranged that the first expedition shall start in September next, the three-masted schooner *St. George*, of approximately 1000 tons register, having been secured for the purpose. The ship, which is designed on the lines of a yacht, is fitted with auxiliary steam-power, and will be under the command of Commander D. Blair. It is intended that seven or eight fully qualified men of science, representing biology in its different branches, ethnology, oceanography, and geology, shall accompany the expedition, and that full opportunities shall be given them for serious scientific work. The expedition will last for about ten months, and the route followed will be Panama, Galapagos, Easter Island, Pitcairn, Gambier Islands, Rapa, Australs, Cook Islands, Tahiti, Rangiroa, Marquesas, Cocos, Panama, Azores. There will be accommodation for not more than thirty paying guests, and the cruise should offer a unique opportunity for any one with scientific interests to visit the Pacific Islands under favourable conditions for research work, which would supplement the organised research of the expedition. The arrangements for the latter are being made by a committee of scientific men who are specialists in the different subjects which will be investigated. The offices of the Association are at 50 Pall Mall, London, S.W.1.

JUNE opened this year with very unfavourable weather conditions. May was dull and cold generally, but statistics of past years show worse weather in May than that experienced this year. The unfavourable atmospheric conditions in May occasioned a drift of cold air over the British Isles from the Arctic regions. A change, however, has occurred since the commencement of June, and the drift of air is chiefly from the Atlantic, with more normal conditions, although the days are mostly decidedly cool. Greenwich records afford a ready comparison with the past for a period of at least 80 years. June 1-6 this year was continuously cold, the day temperatures being below 60°, with the exception of June 3, when a break of warmer weather was experienced over the south-west and south of England, and at Greenwich the maximum in the shade registered 71°, while the sun was shining for 8·4 hours. The lowest mean maximum temperature in June recorded at Greenwich since 1841 is 62·4° in 1909, which is 7·6° below the normal, there being only 3 days during this month with the temperature 70° or above; 1860 and 1916 are the only other years with so small a number of warm days in June. In 1909 the first half of the month was generally cold. In 1903 June was also cold, and the two weeks from June 7-20 were probably colder than any other similar period in June on record; the maximum or day temperature on June 10 was 48·5°, which is the lowest day temperature in June during the last 80 years, and 5° below the coldest day in the early part of June this year.

THE annual conversazione of the Institution of Civil Engineers will be held on Thursday, July 12, at 8 P.M.

SINCE 1917 the Royal Society's Gold Medals have been struck in brass, although the recipients have been informed that in due course the brass copies will be replaced by gold. The receipt of an invitation from a prominent firm of jewellers to view the King's Gold Vase and the Gold Cup made for the Ascot meeting, 1923, gives reason for the hope that at no distant date the Mint may find itself in a position to release the small quantity of gold required to strike these medals in their proper medium.

THE tercentenary of the Oxford University Botanic Garden will be celebrated on Saturday, June 23, in the Garden at 3.30-5.50 P.M. The speakers will include the chancellor of the University, Sir David Prain, the president of Magdalen College, and Sir F. W. Keeble, Sherardian professor of botany in the University.

IT is announced in *Science* that Dr. George K. Burgess has been appointed director of the Bureau of Standards in succession to Dr. S. W. Stratton, who resigned to become president of the Massachusetts Institute of Technology. Dr. Burgess has been connected with the Bureau of Standards for twenty years, becoming chief of the division of metallurgy in 1913.

IN another part of this issue we print an article on the life and work of Blaise Pascal by Prof. H. Wildon Carr. Celebrations commemorating the tercentenary of Pascal's birth are to be held in France on July 8-9. The principal meeting will be in Paris, where the French President will be present at a gathering to be addressed by the Minister for Public Instruction and members of the French Academy. A meeting will also be held at the summit of the Puy de Dôme, the site of Pascal's classical experiment showing the fall of the barometer with increasing height above sea-level.

THE trustees of the British Museum have accepted a portrait of Alfred Russel Wallace, which is being presented to them by a memorial committee of which Sir James Marchant is secretary. The artist is Mr. J. W. Beaufort. The painting will be unveiled in the Central Hall of the Natural History Museum, South Kensington, at 12 noon on Saturday, June 23. Places will be reserved as far as possible for those specially interested in Wallace's work, on the receipt of applications addressed to the Director.

THE arrangements for the International Air Congress, which is to be held in the rooms of the Institution of Civil Engineers, on June 25-30, are now nearly complete. A large number of papers has been received; these have been arranged in four groups, or sections, and the discussions on the four will go on simultaneously. The Congress, of which H.R.H. the Duke of York is president, will be opened at 10 A.M. on June 25 by H.R.H. the Prince of Wales. An inaugural address will be given by the Duke of Atholl, Under Secretary of State for Air; while at the final meeting the closing address will be delivered by the Secretary of State for Air, Sir Samuel Hoare. Among the important papers of general interest may be mentioned those on air mails by General Williamson, on the development of commercial aviation by Mr. Handley Page, on aviation insurance by Mr. Sturge, and on various airship questions by Major Scott and Ing. Nobili. Problems in navigation and in the medical aspects of aviation are not neglected, while the standardisation and the scientific aspects of aviation are represented by papers by Sir Richard T. Glazebrook, Mr. Le Maistre, Wing-Commander Hynes, Dr. Stanton, Mr. Southwell, Mr. McKinnon Wood, and other members of the staff of the Royal Aircraft Establishment.

THE eleventh International Physiological Congress, which will be held at Edinburgh on July 23-27, under the presidency of Sir Edward Sharpey Schafer, is apparently the first scientific meeting of its kind in Scotland, and promises to be very successful. Already more than 250 physiologists from various parts of the world have signified their intention of attending the meeting, and a large number of countries will be represented. The largest contingent from abroad is coming from the United States and Canada, and will number about forty. A second notice has just been circulated, from which we see that, on presentation of an official voucher, return tickets to Edinburgh will be issued at a single fare and a third by any railway booking office in Britain. The provisional programme of the Congress includes a reception by the Lord Provost of Edinburgh and an address by Prof. J. J. R. Macleod, of Toronto, on insulin. Those who intend to take part in the Congress should, unless they have already done so, communicate without delay with one of the secretaries, Prof. G. Barger or Prof. J. C. Meakins, University of Edinburgh.

THE seventh International Congress of Psychology will be held at Oxford on July 26–August 2, and will differ from preceding congresses in that it will be restricted to 200 members, membership being confined to trained psychologists, and a few others approved by the committee. It is hoped to provide international symposia on subjects of present interest, the contributions being circulated in advance, and each day will be devoted to a different aspect of psychology (general, educational, industrial, medical, social, etc.). The mornings will be occupied in the discussion of more general problems (such as the perception of time, the perception of form, the nature of general ability, the concepts of mental and nervous energy, the principles of vocational testing, the psychological value of certain psychoanalytic views), and the afternoons in the presentation of a limited number of papers offered by individual members. Exhibits of apparatus and less technical lectures will be also arranged. The recognised languages of the Congress will be English, French, German, and Italian. Further particulars can be obtained from the assistant secretary, Mr. W. J. H. Sprott, Clare College, Cambridge.

THE ninety-first annual meeting of the British Medical Association is to be held at Portsmouth on July 24-27, and the president-elect, Mr. C. P. Childe, senior surgeon of the Royal Portsmouth Hospital, will deliver his address on the first day of the meeting. The following presidents of sections have been elected :—Medicine : Sir Thomas Horder ; Surgery : Sir Henry Gray ; Obstetrics and Gynæcology : Dr. V. Bonney ; Pathology and Bacteriology : Dr. H. Maclean ; Neurology and Psychological Medicine : Dr. Henry Devine ; Ophthalmology : Sir John Parsons ; Public Health : Dr. A. Mearns Fraser ; Diseases of Children : Dr. E. Cautley ; Laryngology and Otology : Mr. E. B. Waggett ; Radiology and Electrology : Mr. S. Gilbert Scott ; Naval and Military Hygiene : Surgeon Rear-Admiral Sir Percy Bassett-Smith ; Tuberculosis : Sir Henry Gauvain ; Medical Sociology : Mr. H. B. Brackenbury ; Orthopædics : Mr. T. H. Openshaw ; Venereal Diseases : Sir Archdall Reid ; Anæsthetics : Mr. W. J. Essery. A provisional programme has been issued which includes provision for discussions on diabetes (Section of Medicine), in which Dr. F. G. Banting, of the University of Toronto, will take part, on the part played by fungi in disease (Section of Pathology and Bacteriology), to be opened by Dr. A. Castellani, of the London School of Tropical Medicine, and the artificial light treatment of lupus and other forms of tuberculosis (Section of Tuberculosis), to be opened by Dr. Reyn, of the Finsen Light Institute at Copenhagen. The annual exhibition of surgical appliances, foods, drugs, and books will be opened on July 24 and remain open until July 27. The honorary local general secretaries for the meeting are :—Mr. C. A. Scott Ridout, St. Elmo, Clarendon Road, Southsea, and Mr. E. J. Davis Taylor, 20 Clarence Parade, Southsea.

AFTER several unsuccessful attempts under the Russian regime, an institute of geodesy was eventually founded in Finland in 1918. The first report, which has now been published, covers the work accomplished until the end of 1919. The need for accurate triangulation in Finland is great. The existing maps leave much room for improvement. Two chains of triangulation cross the country, one from north to south, surveyed about 1840 in the measurement of an arc of meridian, and the other along the Gulf of Finland from the isthmus of Carelia to the Åland Islands. The latter is very defective and the first is of little use as the triangulation stations were seldom marked on the ground. The first eighteen months of the institute's existence were spent largely in organisation. No funds being available for a new building, a house in Helsingfors was adapted for the purpose. Dr. I. Bonsdorff was appointed director and given a staff of five or six assistants. A small supply of instruments and a library of about 1000 volumes were acquired. It was decided to begin work on a line of primary triangulation from the isthmus of Carelia to the Åland Islands joining to the triangulations of Sweden, Esthonia, and Central Europe. A preliminary reconnaissance for this triangulation was undertaken.

Under the title *Open Air* the proprietors of *Country Life* have commenced the issue of a new monthly magazine for lovers of Nature and outdoor life. All kinds of outdoor activities are to be catered for, and in the first number there appear articles on walking and motoring, camping and yachting, fishing, tennis, birds and flowers, photography and weather forecasting, and the charming scenery of the British countryside. The policy of the magazine is to put within the reach of every one some knowledge of Nature, to increase interest and participation in all outdoor life and pastimes, and to point the way of obtaining the most lasting and satisfying pleasures from the beauties and wonders of Nature. The first number makes a successful attempt to attain this ideal. The articles are simply and attractively written and the illustrations are numerous, charming in effect, and well reproduced. Special mention should be made of the article on Thomas Hardy's county; of the account of the kingfisher at home, by Miss E. L. Turner, illustrated by her own inimitable photographs; and of the description of some of the wild flowers of the countryside by Mr. Bedford. If the standard of the first number is maintained the magazine should appeal to a wide circle of readers.

We have received a copy of the fourth annual report of the Governors of the Imperial Mineral Resources Bureau dealing with the year ended December 31, 1922. The Bureau maintains an intelligence service in matters relating to the mining and metallurgical industries, partly by correspondence with representatives in different parts of the British Empire and by co-operation with various government departments, and partly by a system of indexing published information bearing on mineral resources in all parts of the world. The information thus accumulated is of much value in answering inquiries and compiling reports on mineral resources. This work of answering inquiries and putting producers and consumers in touch with one another is of growing importance in connexion with the Bureau's work. Since the publication of the last report, the compilation of the "Mineral Conspectus of the British Empire and Foreign Countries" for the period 1913–1919 has been almost completed. Special attention is directed to the eight volumes on iron ore dealing with the present and prospective iron-ore supplies of the world, prepared by the request and with the assistance of the National Federation of Iron and Steel Manufacturers. Two legal publications were issued during the year, dealing with Transvaal and British Columbia. A statistical series for the period 1919–1921 is in the press, and the parts dealing with the more important minerals and metals are being published in advance. A review of the mineral industry of the Empire during 1922 is promised at an early date. During the year under review the Bureau continued its efforts towards the unification of mineral statistics, an enterprise in which it is much to be hoped that success will attained.

Part i. vol. 18 of the Journal of the Royal Horticultural Society, dated January 1923, contains much interesting material for students of horticulture. The Rev. A. T. Boscawen has a note upon New Zealand trees and shrubs grown successfully in Cornish gardens; it is illustrated by seven excellently reproduced photographs. Mr. F. C. Stern has an interesting note upon cultivation in a garden made in an old chalk-pit; while few plants succeed in pure chalk rubble, there is a very long list of plants successfully grown in a mixture of chalk and soil. Mr. J. Coutts has a paper upon the cultivation of lilies. As a contribution from the Wisley Laboratory, appears a twenty-page report by Mr. W. J. Dowson upon the wilt disease of Michaelmas daisies; as the result of inoculation experiments the disease is traced to *Cephalosporium Asteris* Dow., provisionally determined as a new species though ultimately culture of the fungus may necessitate its redetermination as a micro-conidial stage of a Fusarium. An important practical conclusion in this paper is the practicability of raising healthy plants by vegetative propagation from diseased stocks, by striking cuttings from the tips of the rooted suckers. Mr. A. H. Hoare briefly describes the Rhododendron bug, *Stephanitis* (*Leptobrysa*) *rhododendri* Horvath, now scheduled under the Sale of Diseased Plants Order of 1922 and the cause of severe damage to rhododendrons in many districts. From the annual report of the council, the Royal Horticultural Society would appear to be in a very prosperous and flourishing condition, the membership of the Society having increased by 1214 during the year 1921.

A note in Nature of May 19, p. 681, referred to the habit of a sparrow in persistently tapping a window pane. Sir David Wilson-Barker writes to say that a chaffinch for about two months last year did almost the same thing, with this difference, that it never settled on the window ledge. Sir David suggests that the bird was playing with its own reflection.

Dr. T. H. C. Stevenson will read a paper on "The Social Distribution of Causes of Death in England and Wales," at a meeting of the Society of Biometricians and Mathematical Statisticians on June 25, at 8 p.m., in the theatre of the Galton Laboratory, University College, London. Visitors will be welcomed.

We have received a copy of No. 142 of the Circular of the Bureau of Standards, entitled "Tables of Thermodynamic Properties of Ammonia." The pamphlet contains some valuable tables, together with an excellent Mollier chart of the properties of ammonia, and should be very useful to those interested in refrigeration.

Messrs. G. Bell and Sons, Ltd., announce the early publication of "The Structure of the Atom," by Prof. E. N. da C. Andrade, and a revised and enlarged edition of "X-rays and Crystal Structure," by Sir William Bragg and Prof. W. L. Bragg, in which the original intention of the authors has been maintained, namely, to describe sufficiently the elements of the physics, the crystallography, the chemistry, and the mathematics required for the understanding of the subject.

THE volume of the *Bulletin International* of the Academy of Sciences of Prague for 1917 appeared in 1919 under new auspices, but with the handsome style and typographic excellence of former issues unimpaired. The Academy continues to publish, in French or German, much geological, anatomical, and physiological work, which will no doubt be recorded in the various *Zentralblätter*; but it is a pleasure to consult these papers in their original form, and to find that their production has so admirably survived the test of political distractions.

THE series of lectures recently given at University College, London, by Sir John Russell and members of the staff of the Rothamsted Experimental Station are to be published by Messrs. Longmans and Co., in the "Rothamsted Monographs of Agricultural Science," under the title of "The Micro-organic Population of the Soil." Another book to be issued by the same publishers is "Lead: Its occurrence in Nature, the modes of its extraction, its properties and uses, with some accounts of its principal compounds," by Dr. J. A. Smythe, in "Monographs on Industrial Chemistry."

THE Geologische Vereinigung continues the issue of its valuable journal, the *Geologische Rundschau*, under the care of Profs. Steinmann, Wilckens, and Cloos, and the subscription price (10 gold marks for foreigners) compares favourably with that of most of our own scientific periodicals. Volume 13, beginning in May 1922, contains original articles, such as that by Steinmann on the uprising of the Andes, as well as the usual critical summaries that embody much independent opinion on the part of their authors. Scientific libraries will do well, by placing the *Rundschau* on their shelves, to keep in touch with a wide range of progressive work, promulgated by progressive thinkers.

PRELIMINARY arrangements for the regular publication of the *Journal of Scientific Instruments* have now been made by the Institute of Physics in co-operation with the National Physical Laboratory. The special attention of those workers who have new designs for instruments is invited to the fact that the *Journal* is to serve as a medium of publication of detailed descriptions and critical surveys of the behaviour of such instruments. Original papers or laboratory and workshop notes dealing with the practical or theoretical aspects of scientific instruments should be sent to the Editor, Dr. John S. Anderson, The National Physical Laboratory, Teddington, Middlesex.

Our Astronomical Column.

PROJECTION OF ALDEBARAN ON THE MOON.—The present series of occultations of Aldebaran has once more directed attention to its apparent projection on the moon's disc when it disappears at the bright limb. The subject is discussed by Mr. R. L. Waterfield in the British Astronomical Association's Journal for March. He describes some interesting experiments that he made, using a card with a minute pinhole and a lamp behind it as an artificial star. It was found that the brighter the illumination of the artificial moon that was made to cover this star, the further was the latter projected on the disc before disappearance.

Since diffraction makes every bright point appear as a disc in the telescope, this will of itself extend the bright limb of the moon beyond its true position, and also extend the disc of Aldebaran inwards; a considerable fraction, but not the whole, of the observed projection is shown to be thus explained. The width of the diffraction ring that can actually be seen depends on the brightness of the object. Thus faint stars do not show the projection.

To explain the full amount of projection observed, it was found necessary to invoke irradiation, which is probably physiological and differs for different observers; this is quite in accord with experience in the case of Aldebaran.

FAMILIES OF ASTEROIDS.—Mr. K. Hirayama's researches on the connexion between the orbits of many of the asteroids have already been mentioned in this column. He returns to the subject in the *Japanese Journal of Astronomy and Geophysics*, vol. i. No. 3. He studies the secular perturbations by Jupiter and the other planets, and finds quantities which he terms "invariable elements," which are a sort of mean of the actual varying elements. The important elements are mean inclination and mean eccentricity. He makes diagrams in which these quantities are taken as ordinate and abscissa, the third important element, the mean motion, being indicated by varying the colour of the dot. He thus finds several families of planets that show such close agreement in these three points that he has no doubt that they had a common origin; he indicates 5 families, each being called after the earliest discovered member of it; the names are Themis, Eos, Coronis, Maria, and Flora, and the numbers of asteroids belonging to them are 25, 23, 15, 13, and 57.

There seems to be little doubt that Mr. Hirayama has hit on a remarkable relation between the orbits of many asteroids, and that there are strong reasons for postulating a common origin for each family. We thus revert in a sense to the old notion of an exploded planet, but a series of disruptions now appears more probable than a single one.

STONYHURST COLLEGE OBSERVATORY, REPORT FOR 1922.—Sunspots are regularly drawn and measured at the College Observatory on every fine day. The spot activity showed a decided decline in 1922, there being 93 days when the sun was seen to be spotless, as against 29 in 1921. On the other hand, the mean daily magnetic range, both in declination and horizontal force, showed a slight increase. Spectroscopic work was also done, both on the sun and on stars, a special study being made of γ Cassiopeiæ. Papers have been contributed to the *Observatory*, to Monthly Notices of the R.A.S. and elsewhere, on the connexion of magnetic disturbances with sunspots, on the prominences, and on the proper motions of stars in the Perseus clusters. Seismological records were also kept. The disturbance in the Chilian earthquake of November 11, 1922, was so great that the boom adhered to the stop, causing a loss of part of the record. The report also contains full details of the meteorological observations. Father Cortie notes that it is intended to utilise the large stock of stellar spectra at the Observatory for the deduction of spectroscopic parallaxes.

Research Items.

MONOLITHS OF THE NAGA TRIBE OF ASSAM.—In the Journal of the Royal Anthropological Institute (vol. lii., 1922) Mr. J. H. Hutton discusses the monoliths erected by the Naga tribes of Assam. He assumes that the monolith erected when the founder gains the highest social rank is the translation into stone of the original phallic posts, which seem to be connected with the monolithic remains at Dinapur. Many Angamis erect a pair instead of a single stone, of which the erect stone represents the male and the prostrate stone the female—the object being a magical means of procuring fertility for the members of the tribe, their cattle, and crops. On the other hand, these monoliths are memorials of the dead. Of two possible explanations, the more likely one is assumed to be that the monolith is merely a translation into stone of the wooden statue erected in honour of the dead by villagers who do not erect memorial stones. The alternative is that the erect stones originally commemorated a feast, and thus became the memorial of the giver. It has always been a problem how monoliths, like those of Stonehenge, were erected. Mr. Hutton was present at the erection of one of these stones, dragged by human labour, and his careful description of the methods employed throws much light on the general question of monolith erection.

THE ROOTING OF CUTTINGS.—Prof. J. Small has a note in the *Gardeners' Chronicle* for May 5 upon his experiments at Belfast, in collaboration with Miss M. J. Lynn, upon the effect of watering with dilute acetic acid upon root production by cut shoots. The experiments appear to be preliminary in nature, and no data are supplied as to the actual hydrion concentration around the base of the cutting, but the results reported certainly seem to show greater root production after treatment with very dilute vinegar. In experiments with cuttings of *Aucuba Japonica* evidence was obtained indicating that carbon dioxide might have a stimulating effect upon root production. These results may prove of great practical importance if confirmed upon further trial, but so far the experiments with species, difficult to strike in ordinary practice, are not sufficiently advanced to justify the drawing of conclusions.

SLEEP MOVEMENTS AND VEGETATIVE REPRODUCTION IN PLANTS.—The *Journal of Indian Botany*, vol. iii., No. 5, contains a paper by W. T. Saxton upon "Nyctinasty," in which it is suggested that instead of the plants adopting a special "sleep" position at night, the leaves then actually resume a normal position, relaxing from a position of "physiological strain" which has been assumed under the influence of daylight. R. H. Dastur has a note upon vegetative reproduction by root runners, in which it is assumed that the current teaching is that buds are only formed upon roots when the plants are old or when the original stems are removed or cut down. The writer is evidently unaware of Beijerinck's classical paper of 1887, in which the natural production of buds on the roots of healthy plants was fully described and the literature of the subject, extensive even at that date, very fully cited.

CHEMISTRY OF SOME JAPANESE PLANT PRODUCTS.—In *Acta Phytochimica*, vol. 1, No. 2, Yasuhiko Asahina gives a résumé of his researches, previously published in Japanese, upon the active principles in the dried fruit of *Evodia rutæcarpa*, which in recent times has been almost exclusively used as tincture in Japan instead of tincture of iodine. In addition to evodin, previously isolated by Keimatsu, Asahina recognises two alkaloids, evodiamin and rutæcarpin, giving different colour reactions with cold concentrated sulphuric acid, and a terpene that is possibly ocimen. Yuji Shibata and Kenshô Kimutsuki make the important suggestion, backed by considerable experimental evidence, that the spectrograph provides a valuable means of identifying and distinguishing the various flavones rapidly and surely, while Keita Shibata, Shôjiro Iwata, and Makoto Nakamura describe baicalin, a compound of a new flavone with glucuronic acid obtained from the roots of *Scutellaria baicalensis*.

INVESTIGATIONS UPON FRUIT TREES.—The *Journal of Pomology and Horticultural Science*, vol. 3, No. 2, April 1923, contains a preliminary report by L. N. Staniland upon the results to date of his quest for apple stocks resistant or immune to woolly aphis. The paper, although preliminary, describes a large number of experiments and observations upon artificial inoculations, from which it appears that the Northern Spy stock is immune under English conditions. As it is not a stock suitable for all purposes in this country, research is now extended to its seedlings, which are also to be tested for immunity. Some of the Paradise stocks at East Malling are very much more resistant than others, while two "Wilding Crabs" have been found which appear to be immune. The search for immune individual stocks is being continued with the view of breeding work in which immunity may be combined with other desirable characteristics. There is also a valuable report by M. B. Crane upon the "Self Sterility and Cross Incompatibility" of cherries, apples, and plums, which describes the continuation of the work upon this problem previously reported upon by I. Sutton in the *Journal of Genetics*, vol. vii. (reprinted in the *Journal of Pomology*, vol. 1). The paper provides an enormous mass of valuable data, supplemented by some striking photographs, of the results of various crosses, and of self-pollination experiments. The results seem to place beyond doubt the fact that many varieties of fruit trees are completely self-sterile, while in the sweet cherry and the plum, cross incompatibility occurs, *i.e.* some varieties crossed with pollen of certain other varieties wholly fail to form fruit. The importance of these conclusions, supported with full data as to varieties and their behaviour, to the grower stocking an orchard, scarcely needs comment. Points of great scientific interest continually arise in the course of such long-continued and carefully controlled experiments; for example, the observation now reported that apple varieties originally quite self-sterile have indubitably become slightly self-fertile with advancing age.

NEW ISOPOD FROM CENTRAL AUSTRALIA.—Prof. C. Chilton describes (Trans. R. Soc. S. Australia, xlvi., 1922) a new species of Phreatoicus, a fresh-water crustacean, which occurred in thousands in the hot water near an artesian bore at Hergott, a little south of Lake Eyre. The specimens had well-developed eyes and were of a dark-slaty colour; hence they evidently had not come up the bore from underground waters. Specimens were later found in various springs and natural waters over an area of about thirty miles, so that the species is widely distributed. Although the species is placed for the present in the genus Phreatoicus, it differs from the other members of the genus in the greater expansion of the basal joints of the last three pairs of peræopods and in the apparent absence of the coxal joints of all the peræopods. The first species of Phreatoicus was described in 1883 from the underground waters of the Canterbury Plains, New Zealand, and other species of the genus and of allied genera were subsequently described from the surface and underground waters of Australia. In 1914, Barnard recorded a species of Phreatoicus from the mountain streams of Cape Colony. The characters and distribution show that the family is an ancient one, and this was proved also by the discovery of a fossil species, from the Triassic beds of New South Wales, not very different from some of the existing species.

NEW SQUALODONTS FROM THE MIOCENE OF MARYLAND.—R. Kellogg describes and figures the remains of two Squalodonts recently discovered in the Calvert Cliffs (Miocene), Maryland (Proc. U.S. Nat. Mus., vol. lxii., Art. 16). Of the two, one is definitely referred to a new species, *Squalodon calvertensis*, the other is at present indeterminate. The introduction to the paper gives a good summary of the history of the Squalodonts generally, and is followed, under the misleading and erroneous title of "Nomenclature," by a descriptive list of the various species and a "key."

THE CONSTITUTION OF CLAYS.—In Bulletin 708 of the U.S. Geological Survey (1922), H. Ries and other authors describe "The High-grade Clays of the Eastern United States." Of all rocks, clays probably offer the greatest difficulties to petrographers. W. Maynard Hutchings (*Geol. Mag.*, 1890, p. 266) prepared thin films from clays for microscopic examination, retaining the particles in their relative positions. Except where lamination has to be studied, no great advantage arises from this method, and H. C. Sorby (Quart. Journ. Geol. Soc., Proc., 1880) did good work on separated grains, which could be pressed down or rolled over under the cover-glass. Allan B. Dick's "smudge" method ("Kaolin, China-clay, etc.," Mus. of Pract. Geology, p. 261, 1914) keeps the constituents matted together for comparison of their optical characters, and something similar seems to be effected by the squeezing-out process adopted in the American researches (Bull. 708, p. 293) by R. C. Somers. His photographs give the impression of coherent sections; but probably only a massing of the mineral particles can be inferred. Chlorite is omitted from the list of minerals observed, and Hutchings failed to recognise it even where altered biotite formed an important constituent of his clays. He found it, however, abundantly in slates derived from the decay of basic igneous rocks, such as his "ash-slates," and H. B. Milner, in his recently published "Introduction to Sedimentary Petrography," regards its appearance in loose sediments as due to the breaking down of slates and schists. It would seem that the green hydrated products from ferromagnesian silicates, wisely called by various authors "chloritic matter," should find a considerable place as constituents of many clays and sandstones, though probably in a highly comminuted form. R. F. Somers recognises halloysite and diaspore in the American clays, in addition to the prevalent flakes of kaolin. The white material known as "indianite" from south-central Indiana is discussed by W. N. Logan (Bull. 708, p. 147), who finds it to consist mainly of the hydrous aluminium silicates, halloysite, and allophane. In the field it is associated and interlocked with a sandstone of Pennsylvanian age, blocks of which graduate into the clay, and H. Ries (p. 161) comes to the very interesting conclusion that the indianite has arisen from replacement of quartz pebbles, through the action of aluminium sulphate spreading from the underlying pyritous shales.

STOKES'S LAW OF FALL OF A SPHERE.—In the issue of the Proceedings of the United States Academy of Sciences for March 15 Prof. Millikan, now of the California Institute of Technology, gives a summary of a theoretical and experimental investigation of the law of fall of a sphere in a viscous fluid which will be published later in full in the *Physical Review*. On theoretical grounds he shows that the viscous resistance to the motion of a sphere of radius a with velocity v in a fluid of viscosity n and mean free path l must be $6\pi anv/(1+A'l/a)$ where A' is a constant which must decrease as the density of the fluid decreases. In order to express this decrease he writes $A'=A+Be^{-ca/l}$ where c is a constant. He finds that his experiments with drops of different materials falling in gases of various constitutions and densities are all reproduced by the complete formula with values of $A+B$ which differ by not more than 3 per cent. from each other.

CURVE FITTING.—In many physical problems, experimental data give the numerical values of a function at regular or irregular intervals of a variable on which the function depends. Often it happens that these experimental values indicate that the function starts at zero, rises to a maximum and then falls again to zero. Frequency distributions, river gauge readings, and certain physical and biological data define functions of this type. In such cases it is often necessary to obtain a theoretical function which gives a reasonable fit to the data and can at the same time be integrated. The constants occurring in the theoretical equation should also be capable of calculation without such laborious computation as to make the work impracticable. In a pamphlet, "A Method of Curve Fitting," issued by the Physical Department of the Egyptian Ministry of Public Works (Cairo, Government Publications Office, 1922, P.T. 5), Mr. S. Krichewsky explains an equation which has been found to include a wide range of observations, including frequency distributions. The equation is

$$z=f(x)=dy/dx=ky^m(a-y)^n,$$

wherein $f(l_1)=f(l_2)=0$, $a=\int_{l_1}^{l_2}f(x)dx$, $y=\int_{l_1}^{x}f(x)dx$, so that z is the ordinate at x, and y the area from l_1 to x. Mr. Krichewsky's method certainly possesses limitations due to the small number of free constants contained in his equation. Much of the pamphlet is concerned with the calculation of the constants to fit the equation to sets of observed data.

HARDENING STAINLESS STEEL.—Messrs. Automatic and Electric Furnaces, Ltd., of Farringdon Road, London, manufacture a special electric furnace for hardening "stainless" cutlery. The demand for stainless cutlery has been affected adversely by the fact that in many cases a permanent edge cannot be obtained by its use. To get over this difficulty the steel is treated as follows: it is first heated in the furnace to a temperature of 970° C. (as shown by the pyrometer) and then cooled in air. It is next reheated to the same temperature and quenched in water. Finally, it is tempered to 220° C. in an electrically heated muffle. A very fine microstructure is thus obtained. Besides its rust-resisting qualities, stainless steel has a thermal conducting coefficient less than one-third that of pure iron. It is an excellent material for making permanent magnets for use in positions where freedom from corrosion is an advantage, as when quenched at 970° C. it has a large coercive force and great remanence. It is also useful for making mirrors of all kinds.

The Liverpool Meeting of the British Association.

THE preliminary programme and invitation circular for the meeting of the British Association to be held at Liverpool on September 12-19, under the presidency of Sir Ernest Rutherford, have just been issued. The Association has met at Liverpool on four previous occasions, the years and the presidents being 1837, Earl of Burlington, afterwards Duke of Devonshire; 1854, Earl of Harrowby; 1870, Prof. Huxley; 1896, Lord Lister. The meeting in 1896 was the fourth largest in the history of the Association, the attendance being 3181, and it is hoped that this number will be exceeded at the forthcoming meeting. Arrangements have been made with the Railway Companies in Great Britain under which members attending the meeting may obtain return tickets to Liverpool on payment of single fare and a third.

The provisional programme of addresses, discussions, etc., is given below, the sections being as follows:—A, Mathematics and Physics; B, Chemistry; C, Geology; D, Zoology; E, Geography; F, Economic Science and Statistics; G, Engineering; H, Anthropology; I, Physiology; J, Psychology; K, Botany; L, Educational Science; M, Agriculture.

Wednesday, September 12, 8.30 P.M.—Inaugural general meeting: presidential address by Sir Ernest Rutherford, on the electrical structure of matter.

Thursday, September 13.—Addresses by presidents of sections:—D, Prof. J. H. Ashworth, on modern zoology, its boundaries and some of its bearings on human welfare. E, Dr. Vaughan Cornish, on the position and opportunity of the British Empire. K, Mr. A. G. Tansley, on the present position of botany. I, Prof. G. H. F. Nuttall, on symbiosis in animals and plants. M, Dr. C. Crowther, on science and the agricultural crisis. Discussions (Sections A, B, G) on cohesion and molecular forces; (Sections F, J) on psychological assumptions underlying economic theory; and (Sections G, J) on vocational tests for engineering trades.

Friday, September 14.—Addresses by presidents of sections: C, Dr. Gertrude Elles, dealing with some aspects of evolutional palæontology. G, Sir H. Fowler, on transport and its indebtedness to science. L, Prof. T. P. Nunn, on the education of Demos. B, Prof. F. G. Donnan, on the physical chemistry of interfaces. J, Dr. C. Burt, on the mental differences between individuals (with special reference to individual psychology in education and industry). Discussions (Sections E, H) on the methods of anthropology in relation to the social sciences; (Sections F, M) on the outlook for British agriculture; and (Sections B, I) on the physical chemistry of membranes in relation to physiological science. Lecture (Section D) by Mr. Julian S. Huxley on the physiology of development in the frog; and by Prof. G. Elliot Smith on the study of man.

Monday, September 17.—Addresses by presidents of sections:—A, Prof. J. C. McLennan, on the origin of spectra; H, Prof. P. E. Newberry, on Egypt as a field for anthropological research; F, Sir W. H. Beveridge, on unemployment and population. Discussions (Sections J, L) on the delinquent child; (Sections E, L) on geography as a basis for a general science course. Lecture (Section K) by Dr. W. L. Balls, on cotton.

Tuesday, September 18.—Discussions (Sections G, L) on the teaching of dynamics; (Sections K, M) on virus diseases of plants; and (Sections E, H) on the origin of domestic animals.

Delegates of the Corresponding Societies will meet on Thursday, September 13, and on Tuesday, September 18, to discuss matters of common interest to the Societies and the Association. The officers of the Conference of the Corresponding Societies are:—*President*: Prof. H. H. Turner. *Vice-President*: Prof. P. G. H. Boswell. *Local Secretary*: Miss E. Warhurst.

An exhibition of scientific apparatus is being organised and will be held in the Central Technical School. Leading scientific instrument and scientific apparatus makers will be represented, and it is believed that this will be the most complete exhibition of its kind that has ever been held. It will include the latest inventions in instruments and apparatus, as well as charts and diagrams, and, in order to make it thoroughly representative, every section has been asked to submit ideas and suggestions.

International Union for Pure and Applied Chemistry.

CONFERENCE AT CAMBRIDGE, JUNE 17-20.

THE International Union for Pure and Applied Chemistry will meet in Cambridge, at the invitation of the Vice-Chancellor of the University, on June 17–June 20, when about 150 delegates, representing more than thirty different countries, will be present.

The majority of the delegates are expected to arrive on Saturday, June 16. On Sunday, June 17, there will be visits to colleges and other places of interest in the afternoon. In the evening there will be a reception of the delegates by Sir William Pope, president of the Union, and the British Federal Council, in the Arts School.

On Monday, June 18, in addition to the meetings of committees, a report by Prof. J. W. McBain, on "The Nature of Soap Solutions," will be presented and discussed. Two receptions will be held on this day, one by the master of Gonville and Caius College and Mrs. Anderson, and the other by the master of Sidney Sussex College and Mrs. Weekes.

On Tuesday, June 19, there will be the usual committee meetings, and in addition two reports will be presented and discussed. The first will be by Dr. E. K. Rideal on "Recent Developments in Contact Catalysis," and the second by Prof. J. F. Thorpe on "New Aspects of Tautomerism." During the afternoon there will be a garden party in the gardens of Sidney Sussex College, and in the evening the annual banquet of the Union will be held in the Hall of Trinity College.

On Wednesday, June 20, after the committee meetings, Prof. F. Gowland Hopkins will present his report on "Chemical Mechanisms involved in the Oxidations which occur in Living Tissues."

At 4 P.M. the degree of Doctor of Science, *honoris causa*, will be conferred on the following delegates: Prof. W. D. Bancroft, Cornell University; Prof. E. J. Cohen, University of Utrecht; M. A. Haller, president of the Paris Academy of Sciences; Prof. C. Moureu, Collège de France; Prof. R. Nasini, University of Pisa; Prof. Amé Pictet, University of Geneva; and Prof. F. Swarts University of Ghent. The ceremony at the Senate House will be followed by a reception by the Vice-Chancellor and Mrs. Pearce in the Fitzwilliam Museum.

Technical Chemistry at the University of Edinburgh.

THE experience gained by Sir James Walker in the manufacture of high explosives during the War strengthened his convictions as to the vital need for strong schools of chemistry in British universities, and led to the view that it might be possible to cater rather more directly for chemistry students aiming distinctly for industrial careers than was possible in Edinburgh at that time. As a result the University instituted a department in technical chemistry to meet the needs of those students who desire definitely to prepare for the practice of chemistry in industry, and now proposes, under a recently instituted ordinance, to grant degrees of B.Sc. in technical chemistry leading to the Ph.D. and D.Sc. degrees.

In order to accommodate its ever-expanding scientific departments, the University recently acquired a site of 115 acres of agricultural land at Liberton, on the southern outskirts of the city. The chemistry department was the first to be given accommodation on the new site, and in 1919 work was begun on a new chemistry building, the first of the King's Buildings of the University, which is now nearing completion. In 1921 a portion of this new chemistry building was set aside for the technical chemistry department, and laboratories were designed to meet its special needs.

To get a clear idea of the technical chemistry department it is advisable briefly to survey the general building of which it forms a part. The chemistry building consists of a two-storey frontage looking towards the city, backed by ranges of single-storey rooms with some cellar accommodation. The two-storey portion contains physical chemistry laboratories, staff rooms, library, and administrative offices. Situated centrally behind this portion is a series of laboratories, having the factory shed type of saw-tooth roof with north window lights, stores, and a number of lecture rooms with necessary service and museum rooms. The lecture rooms are lighted by lanterns supported centrally over the ceilings, and an interesting and convenient feature of this lighting system is the provision of movable ceilings to the lanterns so that by the touch of a button at the lecture bench the ceiling can be lowered to cut off all light from the room for lantern projection purposes. Ventilation is effected by the passage of a gentle current of warmed fresh air across the rooms from front to back. The laboratories are very brightly lighted from above and there is no trouble anywhere with dark corners. Even in winter there is little demand for artificial light during the normal working day. A ventilating fan in one wall of each laboratory near the roof is designed to keep the atmosphere fresh, though the provision of an open fume duct at each student's working place and at each evaporating and drying outfit ensures a reasonably clean atmosphere under heavy working conditions.

Flanking the centrally situated laboratories and lecture rooms are corridors running the whole length of the building and giving access to series of smaller rooms, which run along the east and west fronts of the building. These rooms are research laboratories, balance rooms, etc.

The technical chemistry department is situated at the south-east corner of the building, and apart from its laboratories has the advantages of lecture room, dark room, stores, balance room, etc., accommodation provided in the general scheme. There are three larger and two smaller laboratories, with an adjoining workshop. The larger rooms have north roof lights, and normal ventilation is secured by having some of the windows capable of being opened. Additional ventilation is available when necessary in a uralite fume duct, provided with openings closed by sliding doors, running along the back wall of the laboratories, and discharging to the atmosphere through a large-capacity Keith fan. A bye-pass connexion in the fan house enables this fume duct to be put in connexion with a Campbell fume ejector when required.

The floors are of concrete, and slope to centrally situated grid-covered drains. Further drainage accommodation is provided at intervals round the walls of the rooms.

A system of pipes traverses the walls of the laboratories at a mean height of 4 ft. 6 in., and tap and plug connexions are provided at frequent intervals so that each potential working space has at hand the following services—electric power and light, cold and hot water, steam, gas, compressed air, and vacuum.

Apart from cupboard and shelving accommodation provided as wall fixtures, there is no fixed furniture, but movable tables of various heights are available for use as occasions require.

Plant power units will be driven by their own motors in order to retain maximum flexibility, both as regards equipment and its grouping.

One laboratory is provided with a chimney into which are collected four sheet-iron dampered draught pipes serving as furnace flues. Another room has a range of three superimposed platforms for use where a succession of reactions may require gravity feeds.

Of the smaller rooms one is fitted up on the lines of the larger ones, while the other is designed more as an orthodox chemical research room. Here, however, instead of providing fixed bench accommodation, light movable tables are supplied so that they may be arranged to suit the work in hand.

The technical chemistry courses aim at providing:—

1. A sound instruction in the principles of chemistry.
2. A study of the methods of translating chemical processes from the laboratory to the works, with special attention to the combustion of fuels.
3. Practice in such analyses as those of water, oils, and fuels.
4. Laboratory practice in fundamental operations such as filtration, evaporation, crystallisation, drying, electrolysis, furnace work, nitration, sulphonation, fusion, distillation, etc., with small-scale works plant.
5. A sufficient acquaintance with the elements of engineering practice for the following purposes:
    (*a*) To enable men to co-operate intelligently and satisfactorily with an engineering staff concerned with the provision and working of large-scale plant.
    (*b*) To make men more competent in handling large-scale operations, the success of which is largely dependent on the best use of mechanical and electrical appliances.
    (*c*) To give facility in the interpretation of plans and drawings and sufficient skill in drawing to be able to make working drawings of simple plant parts and structures.
6. An insight into the methods of factory organisation.
7. An acquaintance with methods of factory accounting with the view of a proper understanding of costing processes.
8. When desired—and by special arrangement—detailed study of a particular chemical industry or group of industries.

The Electric Charge of Colloids.[1]

By Prof. H. R. Kruyt, University of Utrecht.

SINCE Hardy's publication in 1900, the electric charge of the particles has been the central problem of colloid chemistry. I propose to develop this point of view for both suspensoids and emulsoids, and indeed in the same manner for both types.

In 1907, Freundlich propounded his theory, according to which the origin of the electric double layer was to be sought in a preferential adsorption of one of the ions of the liquid. This theory was applicable to colloid particles with regard to the external phase, and to capillary electric phenomena with regard to the moving liquid. It gave a satisfactory explanation of many facts concerning the coagulation of suspensoids and of the investigations of Perrin and Elissafoff on electro-omosis, of Kruyt on streaming potentials, and of Powis on cataphoresis. Several problems of colloid chemistry could be elucidated by these investigations, *e.g.* the irregular series of flocculation, peptisation, etc. Nevertheless this theory, according to which the double layer is built up only by ions coming from the external liquid, so that the material of the solid wall does not take any part in the process, could not explain all the facts. Especially the investigations on the alkaline sol of SnO_2, carried out by pupils of Zsigmondy, make it obvious that in this case the inner side of the double layer is built up by stannate and not by hydroxyl ions.

The special conditions of the atoms at the periphery of a crystalline particle can account for the formation of a double layer, as Fajans has pointed out. For example, when a negative sol of AgBr is made from solutions of $AgNO_3$ and KBr, with a slight excess of the latter, the Ag-atoms in the crystal lattice are each surrounded by six Br-atoms, whereas an Ag-atom at the crystal boundary is connected to five only; thus it will attract a Br-ion from the surrounding liquid towards the vacant place. This ion, however, is accompanied by a K-ion, which will place itself near the attracted Br-ion. Thus the double layer is formed by the special selective attraction of the solid phase. This train of thought, when slightly modified, holds too for a disperse amorphous phase. According to Langmuir and Harkins, the molecules at a phase interface are oriented with their electrically polar parts towards the water; therefore the conditions are similar to those at the surface of a crystal lattice.

Has the electric charge in the case of lyophilic colloids, like the proteins, the same capillary electric character as in that of the suspensoids? If not (and most physiologists consider it so), colloid chemistry is on the wrong track. The behaviour of proteins is often explained as if they gave real solutions, electrolytically dissociated as amphoteric electrolytes, following Ostwald's law of dilution. Kruyt and De Jong have made investigations on the sol of agar, the behaviour of which cannot possibly be interpreted in that way, the agar being a carbohydrate though giving a typical lyophilic colloid. They pointed out that there is a considerable decrease of viscosity when small amounts of electrolytes are added, the effect being a function only of the valency of the cation, just as is the case with suspensoids and capillary electric phenomena. This effect is the electro-viscous effect, already predicted years ago by Hardy, and thoroughly discussed in the late von Smoluchowski's last paper.

As the electric charge of the agar particles has, without any doubt, just the same character as that of, say, a gold sol, why should a gelatine sol have a charge of quite another origin? Investigations in collaboration with different pupils (unpublished until now for the most part) have convinced me that with gelatin, glycogen, casein, starch, gum arabic, and even with rubber in benzene, the capillary electric phenomena play the principal rôle and can account for the behaviour, which is often interpreted as if we were not dealing with colloids, but with electrolytes in real solution. The influence, especially, of neutral salts can now be understood much better.

The only difference between suspensoids and emulsoids lies in the fact that the latter are hydrated to a large extent, viscosity showing this fact clearly. Water bound by hydration acts as a stabilising factor, just as the electric charge does. The latter can be removed by electrolytes, as mentioned before, and the hydration by adding alcohol or acetone. When hydration only is removed, there remains a suspensoid with all the typical properties of such. Salting out a protein is a combination of the removal of charge (according to the valency) and of hydration (according to the lyotropic strength). Special experiments with agar have made this obvious.

Dr. Bungenberg de Jong has pointed out that the action of tanning agents, like tannin, is a mere dehydration, causing just the same effects as alcohol, though by a very different mechanism.

As a general conclusion, I wish to emphasise the view that the electric charge of all colloids has the same origin, namely, a capillary electric one. The electric charge of suspensoids is their only stabilising factor, the emulsoids having a second in their hydration. With both, the way in which the double layer is built up is not always independent of the material from which the particle is made: with a gold sol, as well as with an agar sol, the double layer behaves in perfect accord with the adsorption theory of Freundlich. With the sol of stannic oxide, as well as with a protein sol, the ions of the molecules situated in the periphery of the particles play an important rôle in the constitution of the double layer.

The advantage of the train of thought developed here lies in the principle of unity according to which colloid-chemistry can be treated.

[1] Synopsis of a lecture delivered at the Universities of London, Edinburgh, and Aberdeen in May 1923.

Plant Ecology.

IN "Die Vegetationsverhältnisse der Grimselgegend im Gebiet der zukunftigen Stauseen" (Bern, Wyss Erben, fr. 8), Dr. Eduard Frey records the character of the vegetation of an area which will soon be submerged in connexion with a water-power scheme in the upper Aare. The area is of special interest in affording a unique opportunity for studying the colonisation of naked siliceous rock and broken soil exposed by the prolonged retreat of the glaciers. Dr. Frey describes in detail the physical characters of the district and the statics of the different plant associations, and also traces the succession of plant life from the original colonisation of unoccupied rock and debris by lichens and mosses to the ultimate condition in which vascular plants are mainly concerned. He remarks on the crowding in a very narrow space at the edge of the glacier of different plants and plant societies. Compared with the Bernina, the flora of the Grimsel is poor in number of species, a fact due primarily to the uniform character of the mineral which forms the basis of the soil. The general features of the district and its vegetation are illustrated by nine very good photographic plates.

Dr. Mario Jäggli's study of the vegetation of the Maggia delta (" Il delta della Maggia e la sua vegetazione," Rascher, Zürich, fr. 7) on Lake Maggiore, between Locarno and Ascona, deals with a fluctuating low-lying area, just above water-level, or periodically or permanently submerged. The writer describes the general character of the delta and its recent transformations, as well as the climatic conditions in relation to the vegetation. He gives an account of the plant associations at the different levels and also a complete systematic list of the species and their distribution in the area. The work is illustrated by a coloured phyto-geographical map and a section in profile.

A widely differing area forms the subject of a communication by Rolf Nordhagen (" Vegetationsstudien auf der Insel Utsire im westlichen Norwegen " ; Bergens Museums Aarbok, 1920–21, Hefte 1), who gives an account of the vegetation, with the constituent plant-associations and a list of the species, of a small isolated island, about 614 square kilometres in area, off the west coast of Norway. The flora of the island bears a strong resemblance to that of the Faroe Islands, though, unlike the Faroes, it has no high lands, the highest point being only 80 metres above sea-level. The value of the work is enhanced by a large number of photographically produced text-blocks.

University and Educational Intelligence.

CAMBRIDGE.—Mr. H. M. Fox, Gonville and Caius College, has been appointed demonstrator of comparative anatomy. The following members of the staff of the Solar Physics Observatory have been reappointed for five years : Messrs. C. T. R. Wilson, Sidney Sussex College, F. E. Baxandall, C. P. Butler, and W. Moss.

The Committee for Geodesy and Geodynamics reports that funds have now been secured for the erection of a small building for practical work near the Observatory. It is expected to be ready early in July. A grant of 200*l*. has been made by the Royal Society from the Caird Fund towards the purchase of pendulum apparatus for research purposes. A pair of transit instruments, an astronomical clock, and a twelve-inch theodolite have been presented to the School of Geodesy by the Surveyor General of the Trigonometrical Survey of India, with the approval of the Government of India ; and other valuable loans and presents have been received.

Prof. Nils Bohr has been proposed as an honorary member of the Cambridge Philosophical Society on the occasion of his receiving an honorary degree from the University.

LONDON.—The following doctorates have been awarded :—*Ph.D. in Science* : Mr. L. G. F. Dolley (University College) for a thesis entitled " The Compressibilities of Binary Gas Mixtures " ; and Vidya Sagar Puri (King's College) for a thesis entitled " Studies in Alternating Current Electrolysis."

The chairman (the Rt. Hon. the Viscount Chelmsford) and members of University College committee, the Provost and members of the academic staff, will hold a reception at the College on Saturday, July 7. The new anatomy building and the extensions of the physiology and engineering departments will be open to inspection.

MANCHESTER.—The award of the degree of D.Sc. has been recommended to Mr. J. C. Duff for a thesis on " Complex Metallic Ammines," and to Mr. W. F. Rawlinson for papers dealing with X-ray spectra and with the properties of supersonic waves in water.

Mr. W. H. Dearden has been elected Hadfield research scholar in metallography. This is the first award of the scholarship, which was instituted last year by Sir Robert Hadfield on the occasion of the inauguration of the Metallographic Institute at Stockholm. The scholarship is tenable at the Institute, and the scholar works under the direction of Prof. Benedicks. Mr. Dearden was a student of the Department of Metallurgy, 1919–22, and being head of his year in the Final Examination was awarded a graduate scholarship. During the past session he has carried out research on the causes of the failure of manganese bronze as a result of the attack of solders.

OXFORD.—The annual report of the Savilian professor of astronomy, Prof. H. H. Turner, was presented to Convocation on June 5. Reference is made in the report to the seismological work done at the observatory, especially on the determination of the depth at which earthquakes take place, and on the various periodicities which have been found in the recurrence of earthquakes, notably one of about four years which seems to be connected with a change in the earth's interior. In this department Prof. Turner has received much assistance from Mr. J. S. Hughes, of New College, whose services have been made possible by the financial help of Dr. J. E. Crombie, of Aberdeen. Voluntary work on the Vatican Zones of the Astrographic Catalogue has been given by Messrs. F. Sargent, A. Burnet, and C. Martin. Dr. Fotheringham has lectured on ancient chronology, and has published papers on the ' Visibility of the lunar crescent " and on a correction of the secular acceleration of the moon's mean motion as determined from occultations and conjunctions in the Almagest. Mr. F. A. Bellamy has continued his general supervision of the observatory as first assistant, and has published a paper on faint stars with large proper motions on plates of the Oxford Astrographic Catalogue. Miss E. F. Bellamy has continued her revision of the Vatican Zones of the Catalogue.

At the ensuing Encænia it will be proposed to confer the degree of D.Sc. on Sir Ernest Rutherford and on Prof. Louis Lapicque, professor of physiology in the University of Paris.

THE University of Geneva has conferred the degree of doctor *honoris causa* on Prof. A. C. Seward, professor of botany in the University of Cambridge, and on Mr. Douglas W. Freshfield.

APPLICATIONS are invited by the Imperial College of Science and Technology for the Henry George Plimmer fellowship in pathology. Candidates must be qualified to undertake research in morbid anatomy, histological anatomy, chemical pathology, protozoology, bacteriology, and allied subjects in either zoology or medicine or botany. Further particulars can be obtained from the Rector of the College, South Kensington, S.W.7. The latest date for the receipt of applications is June 25.

THE Imperial Education Conference, which will open on June 25 at the Board of Education and remain in session until July 6, is the second conference of its kind, the first having been held in 1911. The Chief of the Imperial General Staff convened an Imperial education conference in 1919, but this was limited to the discussion of problems which had presented themselves to the Imperial Education Committee, War Office, as a result of the experience gained in the working of the educational schemes within the British Army and the Forces of the Dominions. Most of the discussions at the coming conference will take place in private, but there will be public (evening) sessions on June 26, June 27, and July 3 devoted to infant education, the boy-scout and girl-guide movements, and "The Island and the Empire" (paper by Sir Charles Lucas) respectively. Educational films will be exhibited at the Central Hall, Westminster, on July 5, and an exhibition of the work of elementary schools and training colleges in England will be opened by the president of the Board of Education on June 25. No public official announcement has been made by the Board of the subjects to be dealt with in the course of the private discussions.

THE International Federation of University Women sends us a pamphlet (Occasional Paper, No. 2) containing, *inter alia*, an article by Prof. Kristine Bonnevie, of the University of Christiania, on the work of the League of Nations Committee on Intellectual Co-operation, of which she is a member. Prof. Bonnevie is of opinion that the most fruitful field for intellectual co-operation will be found in bibliography, and she notes that a special committee is investigating systems of cataloguing and other questions with the view of facilitating co-operation between libraries of different countries. Another special committee is studying exchanges of professors and students, equivalence of studies, degrees, and diplomas, and the establishment of international scholarship funds and international holiday courses. Information is also being collected about the condition of intellectual life and the conditions of life for intellectual workers (typically university professors and artists) in various countries. Particulars are given of the Federation's campaign for raising funds for the acquisition of Crosby Hall as part of an international university women's residential club-house.

THE April number of "The University Bulletin" issued by the Association of University Teachers contains some interesting statistics of salaries of teachers in the English provincial universities, 15 of the London colleges, the Welsh colleges, and 4 other university colleges. From these statistics the following mean salaries of full-time teachers have been calculated: of 478 professors, 933*l.*; 970 assistant professors, readers, and lecturers, 450*l.*; 548 assistant lecturers and demonstrators, 299*l.* Another table, designed to indicate the extent of the hardship suffered by university teachers who have spent some years in school teaching through those years not counting towards pension, brings out the fact that in 12 universities and university colleges 175 teachers have had 1446 years of school service, while in some as many as one-third of the teachers have taught in schools. Steps are being taken to cultivate relations with teachers in universities in the Dominions Overseas and in the United States. It is stated that university teachers' associations already exist for South Africa, Australia, Melbourne, Queensland, West Australia, and Tasmania, and that others are projected for Manitoba, Saskatchewan, Adelaide, Sydney, and Hong-Kong. The American Association, formed in 1915, embraces 180 institutions in the United States and Canada.

Societies and Academies.

LONDON.

Royal Society, June 7.—Sir Charles **Sherrington** and E. G. T. **Liddell**: Stimulus rhythm in reflex tetanic contraction.—K. N. **Moss**: Some effects of high air temperatures and muscular exertion upon colliers. The mean daily energy value of the food consumed by the colliers investigated was 4712 calories. Men working in hot mines consume more food, and a larger proportion of salted food, than men in cool mines; oxygen consumption per minute in various kinds of work at the face by an efficient collier varies from about 1300 c.c. to 2000 c.c. In persons not acclimatised to heat, the maximum amount of sweat lost per hour is about 1·4 lbs., whereas in a collier accustomed to work in a hot place the maximum loss was 5½ lbs. The sweat contains about 0·2 per cent. of chloride, and the loss of chloride during a shift is very considerable. A group of symptoms known to the men as miners' cramp, or stokers' cramp, is referred to water-poisoning brought about by the combination of great loss of chloride by sweating, excessive drinking of water, and temporary paralysis of renal excretion.—F. A. E. **Crew**: The significance of an anchondroplasia-like condition met with in cattle. Dexter cattle are remarkable for their bodily conformation. They produce four classes of calves in such proportions as to suggest that the Dexter itself is a di-hybrid in respect of its characters—coat colour and bodily conformation. A proportion of these calves are still-born and characteristically deformed, presenting certain constant features simulating closely those which constitute the condition of anchondroplasia in the human. The proportions in which these monstrous calves occur suggest that the "bull-dog" calf results from the action of complementary lethal factors which are amplifying factors producing an exaggerated form of the Dexter characterisation. The pituitary, thyroid, and adrenals are abnormal. The lethal factor in this case is probably such as affects the functioning of the pituitary. It may be possible to eradicate the "bull-dog" calf by breeding methods.

Physical Society, May 25.—Dr. Alexander Russell in the chair.—C. H. **Lees** and J. E. **Calthrop**: The effect of torsion on the thermal and electrical conductivities of metals. A method is described of measuring the effect of twisting on the thermal conductivity of a wire. In each of the steel, aluminium, copper, and lead wires tested the twist decreases the conductivity along the wire by a small amount which is approximately proportional to the square of the twist per unit length. The change of electrical conductivity is in general less than the change of thermal conductivity, but is also approximately proportional to the square of the twist per unit length. A. **Rosen**: The use of the Wien bridge for the measurement of the losses in dielectrics at high voltages, with special reference to electric cables. One difficulty in the application of large potential differences to a bridge is the effect on the arm which has to withstand the high voltage. In the arrangements due to Monasch and Schering, this arm is the known condenser; in the bridge used by the author the voltage is applied to the ratio coils. The errors introduced by earth impedance are eliminated by using the Wagner auxiliary bridge. Measurements can be made on cables, and the use of the double bridge in determining the "wire-to-wire" and "wire-to-sheath" losses in a multi-core cable is described. Corrections due to imperfections of the bridge arms and a simple quantitative theory of the double bridge are given.—C. R. **Darling**: An experiment on the production of an intermittent pressure by boiling water. If a glass tube, open at both ends, and of about 5 mm. bore, be stood in a beaker of boiling water, steam bubbles form at the point of contact, causing the water to rise in the tube. The column of water sinks after a time, and then rises again, the rising and falling occurring at irregular intervals. If, however, the tube be narrowed to about 1 mm. near the top of the water, and widened out considerably just above the water surface, the action becomes regular. The water is apparently superheated at the points of contact of the tube and beaker, so that the steam produced can sustain a higher pressure of water. When the water reaches the widened part it is cooled and increases in density until the extra steam pressure at the bottom of the tube is overcome, when it discharges completely. The capillary bore slows down the rate of flow in both directions. A separating funnel with open tap and short stem is well suited to the experiment. The arrangement constitutes a simple heat engine, with source and sink, automatically passing through a regular cycle of operations.—N. W. **McLachlan**: A novel instrument for recording wireless signals. The device consists essentially of a drum of Swedish iron with an annular recess in which are situated coils of fine wire, the ends of the coils being connected to corresponding slip rings. The periphery of the drum is faced with cast-iron rings. A small steel shoe rides on the rings, and side play is prevented by a brass guide-piece with a projection which fits into the annular recess. At each end of the guide-piece a hook is formed, and one of the hooks is connected by a light rod to a duralumin lever pivoted to turn in a horizontal plane. A silver syphon passes through the lever and rests lightly on a moving paper tape. The drum is revolved by a small electric motor, and when a current flows in one of the coils the shoe is attracted to the drum and a large pull is required to prevent relative motion of the two. This pull actuates the syphon-lever mechanism, which can be used to show the dots and dashes of the Morse code. The instrument is extremely sensitive, and will work at a speed of 150 words a minute with a current of 25 micro-amperes.

EDINBURGH.

Royal Society of Edinburgh, May 21.—Prof. F. O. Bower, president, in the chair.—A. P. **Laurie**: An interesting property of the water molecule. On a modification of Langmuir's theory of chemical combination, namely, that the two nearest magnetons of two approaching atoms, forming the Langmuir pair, move outwards laterally in opposite directions, thus binding the two atoms together as one common molecule, a water molecule has four external magnetons, in addition to the four which are attaching the two hydrogen nuclei. This molecule can, therefore, form groups combining one with another to give hollow shells or rings which have the property, peculiar to water alone, of having no external magnetons. In the same way, the hydrates formed by combining water with a molecule or ion have no external magnetons, the result being the formation in solution of molecular groups, which may be regarded as chemically neutral to each other. They can account for the properties of water solutions of salts, resulting in their obeying the gas laws in dilute solutions, and also for the part played by water as the only possible medium for organic life.—H. Stanley **Allen**: A static model of the hydrogen molecule. A theory of the constitution of molecules is developed on the basis of the "quantum force" introduced by Langmuir with the view of securing a static model of the hydrogen atom. It is here assumed that the "quantum force," which, like the repulsive force employed by Sir J. J. Thomson in the same problem, varies inversely as the cube of the distance, is a repulsion or an attraction according to the sign of the electrical charges between which the force acts. On this assumption a hydrogen molecule is possible, having many of the properties of the molecule imagined by Bohr but with the electrons at rest relatively to the hydrogen nuclei. Various configurations of equilibrium are theoretically possible, but not all of these are stable. The calculated ionisation potentials are in moderately good agreement with the experimental results. Though the numerical values may need modification, it is now possible to postulate a hydrogen molecule in which the electrons are at rest instead of in orbital motion. The principles may be applied to more complex atomic and molecular systems.—Henry **Briggs** and John **Mallinson**: Further tests upon metal Dewar flasks intended to hold liquid air. The pressure in the vacuous envelope was obtained by direct measurement, and a series of results are given for British- and German-made flasks of different kinds. Radiation is by far the chief source of heat transfer in a flask holding liquid air, and further improvement is to be sought only by better attention to the polished surfaces. Losses by conduction down the neck and (unless the vacuum has much deteriorated) by conduction across the vacuous space are generally relatively small in amount. The charcoal used makes it unnecessary to evacuate by pumping to a pressure of less than 0·1 or 0·2 mm. of mercury.

SHEFFIELD.

Society of Glass Technology (at University College, London), May 16.—Prof. W. E. S. Turner, president, in the chair.—F. **Twyman** and F. **Simeon**: On the refractive index changes in optical glass occasioned by chilling and tempering. Chilling dense barium crown and borosilicate crown glasses may lower the refractive index by as much as 0·004 and 0·0013 respectively. This lowering of refractive index can be removed by heating to a temperature and for a length of time which have been ascertained in certain cases. A want of homogeneity can be produced by moulding, owing to surface chilling, which requires for its removal a longer maintenance at the high temperature than would suffice to remove elastic stress from a homogeneous sample.—V. **Stott**: Notes on burettes. Accurate readings can be obtained much more quickly by using a long emptying time and a short drainage than by using a short emptying time and a correspondingly longer drainage time. The errors occurring through using a burette calibrated for a certain delivery time, with a jet which gave a different delivery time are, in some cases, too large to be negligible.—A. **Ferguson**: A new method of glass-melting. The process consists of employing a cone or column of whirling gases at 1800° C., into the vortex of which batch ground to a 60-mesh standard is dribbled at the rate of two pounds per second; the carbon dioxide of the limespar and soda ash is first driven off in a preheater, so that the work of the furnace is only to raise the temperature from 850° C. to 1350° C. instead of from 20° C. All reactions necessary to form glass molecules take place in a gas at least two million times less viscous than tank metal.—S. **English**: Natural sillimanite as a glass refractory. This material possesses properties of considerable value to glass-makers. Test pieces were made up by mixing 100 parts of sieved sillimanite with 10 parts of finely ground ball clay; such a mixture can be made into slabs and pressed into crucibles, if care is taken in working it.

DUBLIN.

Royal Irish Academy, May 28.—Prof. Sydney Young, president, in the chair.—J. J. **Drumm**: The constitution of catechin, Part I. Benzopyranol salts are prepared from catechin of a type closely allied to the anthocyanidins. Von Kostanecki's coumarane formula for catechin is no longer tenable; A. G. Perkin's chromane formula with slight modifications is again put forward.

Royal Dublin Society, May 29.—Prof. J. A. Scott in the chair.—Rev. H. C. **Browne**: A simple from of photographic depth chart. The chart consists of four concurrent lines, and may conveniently be drawn on squared paper. A straight edge laid anywhere across these lines intersects them in points which give respectively the stop diameter, the nearest distance in focus, the distance to be sharply focussed on, and the furthest distance in focus. The readings are all direct, reciprocals being avoided. Three sample charts were described, one suited for general work, a second especially adapted for the photography of small objects at short distances and on an enlarged scale up to 12 or more diameters, and a third intended for carrying in a photographic note-book, which, though only $3\frac{1}{2}$ in. × $2\frac{1}{2}$ in. in size, gives clear readings for distances up to 60 feet, and stop diameters up to 1·5 inches.—T. G. **Mason**: Ligneous zonation and die-back in the lime (*Citrus medica*, var. *acida*) in the West Indies. Tangential bands of parenchyma are distributed in the wood in both normal lime tree and in specimens affected with "die-back"; they originate during periods of relatively great aridity. The wood from trees affected with die-back exhibits considerable irregularity in the distribution of the parenchyma bands, and the sections suggest that the cambium had been exposed to sudden checks in its activity. Rapid and repeated desiccation of the meristems may be an important factor in causing die-back of the lime.—L. B. **Smyth**: On a problematic structure in the Oldhamia Rocks of Bray Head. These rocks consist of scattered tabular bodies 0·3 mm. in thickness, with rectilinear outlines and of variable size (average, 1-3 mm. diameter) and shape, lying on a bedding plane of chlorite-sericite shale. Their composition differs from that of the shale only by the greater proportion of chlorite. A considerable number of the bodies are lozenge-shaped. They may be crushed pseudomorphs of crystals.

PARIS.

Academy of Sciences, May 22.—M. Albin Haller in the chair. The president announced the death of M. de Freycinet, Free Academician.—A. **Vayssière**: The characters suitable for classifying the gasteropods of the family of the Cypræideæ. These have hitherto been mainly classified according to the character of the shell and this is shown to be insufficient.—M. **Pélissier**: An account of the formation of a new volcanic island south of Poulo-Cécir de Mer. Plans of the island and crater, together with a chart showing soundings round the new island are given.—Paul **Lévy**: A functional operation generalising the derivation of non-integral order.—P. **Zervos**: Some transformations of partial differential equations.—A. **Guillet**: The rapid and precise measurement of the frequency of rotation of the shaft of a motor by the stroboscopic method. A description of the construction and use of an improved form of stretched wire stroboscope.—M. **Dumanois**: The utilisation (in a motor) of a mixture of lamp oil and alcohol containing a high percentage of the latter. A mixture of alcohol (70 per cent.) and kerosene (30 per cent.) was successfully used to replace petrol in a motor car: the car was run on this mixture (after suitably modifying the carburettor) from Paris to Toulouse, 450 miles, without trouble.—Jean **Durand**: Contribution to the study of methods of testing foundry iron.—Albert **Bazin**: The hovering flight of birds: flights without motor in undulating winds.—M. **Auric**: Demonstration of Stefan's law.—A. **Leduc**: The loop of J. Thomson and the new equation of state of gases.—E. **Brylinski**: The propagation of maintained electromagnetic waves along an iron wire. Remarks on a recent communication of M. G. Laville on the same subject.—J. **Rossignol**: Researches on the cathode phosphorescence of the ruby. An examination of the influence of the velocity of the stimulating cathodic electrons on the law of decrease of phosphorescence of the ruby with time. Synthetic rubies were employed, with percentages of chromic oxide varying between 0·1 per cent. and 10 per cent. Curves for one ruby are given, showing the relation between the intensity of phosphoresence, voltage of the poles of the cathode tube, and fall of intensity with the time.—Mlle. Irène **Curie**: An arrangement for measuring strong ionisations due to the α-rays. The principle of the method consists in utilising for the ionisation current only a fraction of the α-rays. This portion is allowed to escape through sectors in a brass cover and the ratio of reduction, which can be varied, may be as high as $\frac{1}{1500}$.—M. **Volmar**: The action of light on the tartar emetics. Tartrates of the type $CO_2H . CH(OH) . CHO(RO) . CO_2K$, in which R may be antimony, arsenic or bismuth, are decomposed by ultra violet light, gas being evolved (carbon dioxide, carbon monoxide and hydrogen and hydrocarbons in the case of antimony), and metal deposited. Double tartrates of copper and of iron are also changed by exposure to light of short wave length.—Albert **Noyes**, jun.: The photochemical decomposition of solid bodies.—A. **Bigot**: Kaolins, clays, etc. Colloidal plasticity. Experiments on baking clay briquettes prepared in different ways, compression of dry powder, compression of slightly moistened powder, reduction to plastic state with water. The colloids play an important part in the results of firing ceramic materials.—F. **Zambonini**: Thorium molybdate, $Th(Mo O_4)_2$. An account of the mode of preparation, crystal form and molecular volume of thorium molybdate.—Pierre **Jolibois** and Pierre **Lefebvre**: Baking of plaster of Paris and its preservation in moist air. Plaster of Paris which has been dehydrated at temperatures between 150° and 300° C. rapidly absorbs water vapour from saturated air: if the dehydration temperature has been above 400° C. the rate of absorption of water vapour is very slow.—F. **Diénert** and F. **Wandenbulcke**: The estimation of silica in water. The method suggested is based on the colour developed by the addition of ammonium molybdate and dilute sulphuric acid, utilising a standard solution of picric acid as a colour standard.—Max and Michel **Polonovski**: Ethescrolene.—Ch. **Mauguin**: The arrangement of the atoms in crystals of cinnabar. The results of an X-ray study of cinnabar crystals.—Mlle. Gertrude **Weber**: The limit between the Danian and the Maestrichtian in the Crimea.—L. **Vegard**: The constitution of the upper layers of the atmosphere. In a previous communication on the spectrum of the aurora borealis it has been shown that nitrogen is the dominating element at the upper limit of the atmosphere. It is probable that the nitrogen is solidified in the form of small crystals, and that this nitrogen dust is charged electrically by the photoelectric effect of the solar radiation.—Henri **Coupin**: Remarks on the locomotion of the Oscillatoria.—H. **Colin** and H. **Belval**: The supposed reserve dextrins of Monocotyledons. A revision of the work of Leclerc du Sablon (1898–1899). The bulb of *Hyacinthus orientalis* contains no dextrin: the reserve carbohydrates consist of starch and a soluble levulosan only.—R. de **Litardière**: Remarks on the fixation of Merkel's liquid and on certain so-called nuclear structures provoked by fixing reagents with osmic acid base. An adverse criticism of the results of Overton on the somatic kinesis in *Podophyllum peltatum*, with special reference to the action of various fixing fluids.—Raphael **Dubois**: The toxicity of copper with respect to moulds. Remarking on a recent communication by M. and Mme. Villedieu on the non-toxic action of copper on moulds, the author directs attention to the fact that he arrived at a similar conclusion in 1890. An explanation of the undoubted beneficial effects of copper suspensions in fighting mould in the vine and other plants has still to be found, and it is suggested that since it has been shown that salts of copper may act both as oxydase and peroxydase, this may be the cause of the observed beneficial action.—Jivoin **Georgévitch**: New researches on the Goloubatz fly. From the heads of this fly a poisonous substance can be extracted by either water, alcohol, chloroform, or ether, and injections of this material proved rapidly fatal to guinea-pigs, rabbits, and white mice. Losses of cattle through the ravages of this fly have been unusually heavy this year in Serbia, Roumania, and Bulgaria.—Alfred **Maubert**, Léon **Jaloustre**, and Pierre **Lemay**: The influence of thorium-X on the catalase of the liver. Thorium-X acts on catalase from the liver, stimulating in small doses and paralysing in large doses. The action is due to the α-radiation.—René **Jeannel**: The origin of the entomological fauna of the Carpathians and of the Bihor mountains.—Pierre **Lesne**: A new appearance of *Leucotermes lucifugus*. A Strelitzia in the hot-house of the Natural History Museum at Paris has been found to have been seriously attacked by this ant.—Alphonse **Labbé**: The genesis of the nemato cysts of the nudibranchs.

Calcutta.

Asiatic Society of Bengal, May 2.—B. **Prashad**: Observations on the luminosity of some animals in the Gangetic Delta. Notes on the various methods of the production of light by different animals are given.—N. **Annandale**: Plant and animal designs in the mural decorations of an Uriya village. The designs discussed are painted on the walls of houses on an island in the Chilka Lake. They are mostly of a very simple nature, consisting of outlines in white chalk on a red background. The plants or parts of plants most commonly represented are the maize, the cocoanut, the sola plant, and the kadumba flower; the animals—ducks, peacocks, and fish. The last are always represented in pairs, forming a well-known Indian symbol. Other symbols such as the footprints of Krishna are combined with the plant designs.—Johan van **Manen**: on the 44th verse of the Dhammapada. Comparison of the Pali, Prakrit, Chinese, and Tibetan versions, with conclusions concerning "metaphysical punning" as an essential element of some of the earliest Buddhist utterances, ascribed to the Buddha himself.

Official Publications Received.

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1923, June 2. Pp. 20. (Greenwich.)

Eleventh Report of the Microbiological Laboratory (Government Bureau of Microbiology) for the Year 1920. (Extract from the Report of the Director-General of Public Health, New South Wales, for the Year ended 31st December 1920, Section 4.) Pp. 131-195. (Sydney: J. A. Spence.)

Twelfth Report of the Microbiological Laboratory (Government Bureau of Microbiology) for the Year 1921. (Extract from the Report of the Director-General of Public Health, New South Wales, for the Year ended 31st December 1921, Section 4.) Pp. 81-94. (Sydney: J. A. Spence.)

Sudan Government: Wellcome Tropical Research Laboratories, Khartoum. Report of the Government Chemist for the Year 1922. Chemical Section—Publication No. 26. Pp. 30. (Khartoum.)

Department of the Interior: United States Geological Survey. Bulletin 686: Structure and Oil and Gas Resources of the Osage Reservation, Oklahoma. By David White and others. Pp. xvi+427+60 plates. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 480: Surface Water Supply of the United States, 1918. Part 10: The Great Basin. Pp. vi+271. 20 cents. Water-Supply Paper 483: Surface Water Supply of the United States, 1918. Part 12: North Pacific Drainage Basins. B: Snake River Basin. Pp. v+171. 15 cents. Water-Supply Paper 508: Surface Water Supply of the United States, 1919–1920. Part 8: Western Gulf of Mexico Basins. Pp. iv+136. 15 cents. (Washington: Government Printing Office.)

Annales de l'Observatoire Royal de Belgique. Troisième série, tome 1, fascicule 2. Pp. 269-415. (Bruxelles: M. Hayez.)

Diary of Societies.

SATURDAY, June 16.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (VI.).

MONDAY, June 18.

Aristotelian Society (at University of London Club), at 8.—Prof. G. Dawes Hicks: The Nature of Images.

Royal Geographical Society (at Æolian Hall), at 8.30.—Capt C. J. Morris: The Gorge of the Arun.

TUESDAY, June 19.

Royal Society of Medicine (Special General Meeting), at 5.

Royal Statistical Society, at 5.15.—Prof. A. L. Bowley: Death Rates, Density and Population.—Dr. J. C. Dunlop: Misstatement of Age in the Returns of the Census of Scotland.

Mineralogical Society (at Geological Society), at 5.30.—Dr. L. J. Spencer, with chemical analyses by E. D. Mountain: New Lead-Copper Minerals from the Mendip Hills (Somerset).—Dr. W. F. P. McLintock: A Petalite-bearing Rock from Devonshire.—A. Brammall and H. F. Harwood: Dartmoor Granite; Monazite and other Accessory Minerals; Tourmalinisation.—S. Tsuboi: Optical Dispersion of Three Intermediate Plagioclases.—S. Tsuboi: A Method of determining Plagioclases in Fine Grains.—C. S. Garnett: The Toadstone Clays of Derbyshire.—Dr. G. T. Prior: The Meteoric Stone which fell at Ashdon, Essex, on March 9, 1923.—Dr. G. T. Prior: The Sinai Meteorite.

Royal Anthropological Institute, at 8.15.—Prof. P. G. H. Boswell and J. Reid Moir: Flint Implements at Foxhall Road, Ipswich.

WEDNESDAY, June 20.

Royal Meteorological Society, at 5.—J. Edmund Clark and I. D. Margary: Report on the Phenological Observations in the British Isles from December 1921 to November 1922.—Dr. T. G. Longstaff: Meteorological Notes from the Mount Everest Expedition of 1922.—R. Arnison: Exhibit of a new form of Open-scale Barograph by Short and Mason, Ltd.

Geological Society of London, at 5.30.—K. S. Sandford: The River-Gravels of the Oxford District.—L. Dollo and P. Teilhard de Chardin: The Deposits of Paleocene Mammalia in Belgium.

Society for Constructive Birth Control and Racial Progress (at Essex Hall, Strand), at 8.—J. Lort-Williams: Birth Control as it interests me. (Lecture.)

THURSDAY, June 21.

Royal Society, at 4.30.—Dr. F. F. Blackman: Plant Respiration as a Catalytic Process (Croonian Lecture).

Royal Society of Medicine (Dermatology Section), at 5.—Sir Archdall Reid: New Method of treating Skin Diseases.

Linnean Society of London, at 5.—E. Heron-Allen and A. Earland: The Foraminifera of Lord Howe Island.—T. A. Dymes: The Seeds of the Marsh Orchids.—Prof. A. Dendy and L. M. Frederick: A Collection of Sponges from the Abrolhos Islands.—Prof. M. Zalessky: Some New Species of Permian Osmundaceæ.—Dr. Ethel N. M. Thomas: Observations on the Seedling Anatomy of the Genus *Ricinus*.—Dr. C. H. O'Donoghue: Opisthobranchiata from the Abrolhos Islands.—C. N. Withycombe: The Function of the Bladders in *Utricularia vulgaris* L.

Chemical Society, at 8.—O. R. Howell: The Constitution of the Higher Oxide of Nickel.—F. Allsop and J. Kenner: The Relationship of the Tautomeric Hydrogen Theory to the Theory of Induced Alternate Polarities.—S. Sugden: Electron Valency Theories and Stereochemistry.—Prof. W. A. Bone, D. M. Newitt, and D. T. A. Townend: The Relative Influences of Water Vapour and Hydrogen upon the Combustion of Carbon Monoxide-Air Mixtures at High Temperatures.—I. W. Wark: Metallic Hydroxy-Acid Complexes. Part I. Cuprilactates.—I. W. Wark: Metallic Hydroxy-Acid Complexes. Part II. Cuprimalates, their Formation, Properties, and Composition.—S. Minovici: Cholesterol and its Rôle in the Organism.

FRIDAY, June 22.

Physical Society of London (at Imperial College of Science and Technology), at 5.—Prof. F. Horton: The Excitation and Ionisation Potentials of Gases and Vapours. (Lecture.)

NATURE

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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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University and Secondary Education.

AT the break of gauge between school and university some confusion and loss of time must be expected in a country where both systems are not subject to the control of a state department, and will be excessive unless the responsible authorities on both sides are in general accord as to aims and principles. In England the Board of Education has, during the past twenty years, worked steadily for such an accord and has provided machinery, such as the Secondary School Examinations Council, for making it effective. The report of the Committee on Natural Science in Education helped to focus attention on the subject.

This Committee held that it is desirable on educational and other grounds that boys who intend to pass on to a university should, as a rule, remain at school up to the age of 18 ; that a general course, which should include science work planned as a self-contained course of physics and chemistry with some study of plant and animal life, should be completed normally about the age of 16, when the First School Examination should be taken. This should be followed by two years of advanced work at school during which those specialising in science should continue some literary study and those specialising in literary study should give some time to science work. Then the universities should adopt such an examination as the First School Examination as the normal test for entrance, with such limitations or amplifications as they may find necessary, *e.g.* "credit" in a certain number of subjects or some measure of success in the Second Examination. It was also considered most important that university degree courses in pure science should be so arranged that students who come well prepared from secondary schools should not be put back to do elementary work.

The dovetailing (without wasteful overlapping) of two years of specialised study in the secondary school with the first year of university work presents certain difficulties. Endeavouring to guard against the mishandling of these difficulties, the Committee points out that it is undesirable that work of pupils between 16 and 18 should be disturbed by having to prepare for an examination (for example, the University Intermediate) not primarily designed to meet school needs ; candidates in a Second School Examination who do satisfactory work in any of the subjects required for the Intermediate should, therefore, be exempted from further examination in these subjects. This warning is emphasised in Sir Frederic Kenyon's report of conferences on secondary and university education between the Council for Humanistic Studies and the Conjoint Board of Scientific Societies. The following resolution was passed by the conference :-

"A clear distinction *in kind* between the first-year studies of a university in any faculty and the upper-form studies of a school is a fundamental principle of education. A school year should, therefore, in no case be reckoned as the equivalent of a university year, and the practice of allowing pupils to present themselves for a university examination, beyond the matriculation, before or upon entrance to a university is to be deprecated as confusing the educational functions of school and university and leading to an inappropriate type of teaching at both."

In the best secondary schools the science work is really on as high a plane in every respect as that done in the first year at some of the universities, and the staffs are just as well qualified. Pupils from such schools should be able to obtain exemption from the whole of the Intermediate examination: in other cases partial exemption is valuable as minimising the university student's pre-occupation with the business of preparing for examination. But the introduction of advanced courses in secondary schools ought not to be allowed to obscure the principle that work in those schools should be based on the mastery of fundamentals.

As to the results of neglecting this principle, a useful lesson may be learnt from the recent history of education in the United States, as interpreted by the president of the Carnegie Foundation for the Advancement of Teaching in his report for 1921–22. This indicates such confusion of aims and principles and, in consequence, waste, that by correlation and simplification of curricula the normal aggregate duration of studies in the elementary and secondary schools and the college of liberal arts could be reduced with great advantage to all concerned from 16 years to 12.

The typical American secondary school, known as the high school, was formerly called the "People's College," and gave an intellectual training quite comparable with that provided in the authentic college, which was itself little more than a secondary school. The courses were on parallel lines and were such as were deemed suitable respectively for pupils destined for trade and industrial occupations and for those who would enter the learned professions. From being parallel the high school by degrees became anterior to the college course. Hypnotised on one hand by the social prestige of the college for which it came to serve as a vestibule, and driven, on the other, to cater for the needs of pupils who ought to have been in trade schools, the high school became involved in an attempt to teach something of everything from typewriting to psychology. Meanwhile the colleges, although assuming some of the functions of the university, continued to give during the first two years of the college course what was really secondary education. Surveying the situation with special reference to the rate of increase, lately accelerated in the cost of education, the report deplores the results of the so-called enrichment of the secondary school curriculum:

"The high school of to-day has been transformed from a distinctively intellectual agency into one that offers instruction concerning every field of human knowledge, and assumes to provide training for every vocation and profession. . . . In the process the notions of sincerity and thoroughness in education have been displaced. . . . The striking characteristic of our schools under the process of enrichment of the curriculum is superficiality. . . . The total result is to present education and to present technical training as ends to be gained by superficial means. It would be difficult to find a graduate of our undergraduate colleges who knows his native language, who has read the books, or who has done the thinking, of the youth of eighteen who graduates from a German gymnasium, from a French Lycée, or from an English Public School like Eton or Harrow. . . . He knows almost nothing of intellectual discipline, and is neither able nor in the mood to bend himself heartily and effectively to a sharp intellectual task."

It is interesting to compare with this the notes written eighteen years ago by Mr. A. C. Benson, after twenty years' experience of teaching at Eton, on the system then prevalent in English secondary schools and colleges:

"We send out so many boys not only without intellectual life, but not even capable of humble usefulness . . . they have not had time to read any English to speak of . . . I would raise the standards of simple education, and force boys to show that they are working honestly . . . a few subjects thoroughly taught are infinitely better than a large number of subjects flabbily taught. . . . It is difficult to imagine a condition of greater vacuity than that in which a man leaves the university after taking a pass degree. . . . The education is of a contemptible, smattering kind; it is really no education at all. It gives no grip, or vigour or stimulus."

Since then this critic's conception of the principles and aims of secondary education have been widely adopted, and it is owing to the consequent improvement of British secondary school teaching that it can so well bear comparison with the American system, which seems to be now afflicted with some of the former vices of the British. But it would be a mistake to assume that these vices have been eradicated completely and for ever from the British system. They have their roots in human nature, and we must be on the alert to detect their revival. It is certain that attempts to give effect to the recent recommendation of the Consultative Committee of the Board of Education that a more prominent place in the ordinary curriculum should be assigned to æsthetic subjects will entail conditions favourable to precisely that illusive "enrichment" of the curriculum which has had such unfortunate results in America. The recommendation itself is well founded and, given teachers capable of an adequate conception of the meaning of art, whose æsthetic faculties have been adequately cultivated, nothing but good can result from its adoption, but circumspection is needed; art, like religion, is caught rather than learned.

In the February number of the United States publication *School Life* appears a somewhat detailed description of a type of school organisation adopted by certain "progressive" city school boards, notably in Detroit, Pittsburgh, and Akron, with the object of providing the varied curriculum and instruction by specialist teachers now generally demanded, while keeping expenses within reasonable bounds. The pupils spend half of each day in ordinary class-rooms or "home-rooms," where they are taught formal subjects—reading, writing, arithmetic, formal language, hygiene, and history—and the other half in special rooms or laboratories where they are taught by specialist teachers of science, art, music, literature, manual training or shop work, domestic science, etc. One of these rooms called the auditorium is devoted to co-ordinating all other work by dramatisations and other modes of expression, vocational guidance, and various devices for preparing pupils "for more complete living and the self-control and self-direction needed therefor." These "platoon" or "work-study-play" schools use all their rooms all the time, each of the teachers in the "home-rooms" having the care of two groups of pupils, one in each half of the day. Equipment is minimised and the cost of supplies lessened. Supervision is easier because fewer teachers are responsible for results in any one subject. "Properly directed, the platoon school epitomises socialised education."

Technology of Fuels.

American Fuels. By Dr. Raymond Foss Bacon and William Allen Hamor. (Mellon Institute Technochemical Series.) In 2 vols. Vol. 1. Pp. ix+628. Vol. 2. Pp. vi + 629-1257. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 60*s.*

In the preface of this work the authors or editors, one of whom is a consulting chemical engineer of New York and formerly a director of the Mellon Institute, and the other the assistant director of that Institute, state that "they have attempted to condense into a series of specially prepared chapters the fruits of the experience of specialists, thereby placing in the hands of manufacturers, engineers, and chemists a composite book representing authoritative accounts of the fuels now regarded as technically important in the United States."

The immediate responsibility of the two authors is therefore limited, since other names are attached to most of the twenty-six chapters into which the work is divided. Most of these names guarantee a first-hand knowledge of the subject treated, and the editors "hope that the treatise will be found to give informative summaries of sound practice and the practical details which are generally not to be found in the literature." This method of treatment has both advantages and disadvantages. The book abounds with detailed information on all sorts of subjects connected with the treatment of fuel, and of apparatus designed for its utilisation, information of a quantity and quality which it would have been exceedingly difficult, if not impossible, for any one or two authors to provide. At the same time the number of subjects and appliances treated is so great, and their detailed consideration covers so much ground, that it has been impossible for the editors to maintain any attitude of appraisement or to reconcile what may be regarded as conflicting claims. To have done so would have been a very awkward task and would have lengthened the book unduly, although it must be remembered that, in consulting it for the purpose of making a selection of a process or apparatus, the reader will be called upon to do this for himself.

The editors say "some of the chapters have been written from the viewpoint of men who are enthusiastic advocates of the particular fuels treated," and reading the book will undoubtedly lead a discriminating reader to the same conclusion. The treatment awarded to some of the processes and appliances is such as one would expect to find in the correspondence of a well-informed agent, or in an intelligently prepared catalogue, and its appearance in a book of this kind is unusual. This is not said in a spirit of condemnation, but is intended to convey a warning, which may be necessary, to a reader who consults it in any expectation of finding the judicial statements on processes and plant to which we have become accustomed in the best of our technical literature.

Approached in the proper spirit, the book is undoubtedly one which can be made of very great service to everybody concerned with its subject-matter. There is, however, an aspect of this work to which some exception may be taken by those who look for well-balanced international treatment in scientific and technological writing. To some extent criticism from this point of view is disarmed by the title, but although fuels may be American, the technology of fuel is international and the scientific basis of that technology even more so. The authors cannot, however, be said to be very deeply imbued with this principle. The reader will reap some advantage from the process of selection which has taken place, inasmuch as this work will present to his notice much more fully the contributions to the science and practice of fuel technology which have been made by America than would have been possible in anything like the same compass if corresponding notice had been taken of contributions to the subject from other than American sources. Partly perhaps on this account, the scientific treatment of fundamentals is somewhat sketchy and inadequate. Here, again, if the book is approached with the full knowledge that it is primarily concerned with the setting out of American contributions to fuel technology and the treatment of American fuels (the latter according to title), little harm is done, and the many excellences of the book can be utilised to the full.

Reviewing the work more systematically, after a first chapter on "The Coals of the United States" (which includes a six-page table of analyses of representative coals), and a second on "The Principles of Combustion," we find a full and informing chapter on "The Technology of Coke," by F. W. Sperr, the chief chemist of the Koppers Company, Pittsburgh. This occupies 160 pages, and is well done, although it is charitable to suppose that the work of Sir George Beilby and others on the structure of coke during the last two years must have been published a little too late to allow of its consideration. A useful inclusion here is a summary on methods of sampling and testing. Briquetted or compressed fuels are treated next, and various processes are described, but when the author says that "there are no unsolved fundamental problems in briquetting practically any kind of material, especially in the field of fuel," and that "there is nothing that stands in the way of the design and construction of a briquetting plant to briquet any kind of coal," he will find many to question his judgment.

An excellent economic review of coal preparation raises a number of interesting questions, and in discussing power-generation and the possibilities of the turbine we are told that "higher efficiencies may be more readily obtained by using two vapors in series, such as mercury and steam. Mercury vapor has a much greater density than steam and a lower heat of vaporisation; hence the spouting velocity is low and it may be used in a high-temperature turbine of very simple design. A mercury turbine and boiler are being developed by the General Electric Co."

"The Gasification of Fuels," including that of low-grade fuels, is broadly treated by Mr. Coffin of the General Electric Co., and conveys a detailed description of a horizontal rotary gas producer made by the General Reduction Gas and By-Products Co., for which quite high thermal efficiencies are claimed, and the capacity to deal with most unpromising materials, such as anthracite slush containing 20 per cent. moisture and 25 per cent. ash, a mixture of coke breeze and slush containing 45 per cent. of ash, and sawdust. The statement is made that it has been found possible to make methane from blue gas synthetically in the presence of a nickel catalyser, but an expansion of the term "possible" would have been useful in this connexion.

In the chapter on the "Distillation of Coal at Low Temperatures" the excellent and comprehensive review of the history, theory, and practice of the low-temperature carbonisation of coal, which was submitted to the Society of Chemical Industry by Mr. Edgar C. Evans, has been printed in condensed form, and a number of processes are described in some detail. One of the most interesting chapters is on the use of finely divided fuel, the technique of this subject having been much more highly developed in America than in Great Britain. A chapter on "Fuel Oil and its Utilisation" is followed by one on "Colloidal Fuel," for which that well-known authority on the subject—Mr. Lindon W. Bates—has made himself responsible. Natural gas and producer gas technology are treated in turn, and we are informed that "lack of proper operating organisation has been the cause of many failures," and that "another cause is the over-enthusiastic salesman. Most producer projects look good on paper." There is a section on freak producers, and a summary which includes such prohibitions as "Do not employ an engineer who has never made a mistake on producer gas work," and "Do not lose your nerve after the first six months of operation."

Water-gas does not receive anything like so much attention as might have been expected in an American work of to-day, and although some costs are given there is no satisfactory thermal or chemical analysis of the process.

The chapter on "Blast Furnace Gas" is short, but useful. It is followed by one on the Dayton process, little known in Great Britain, which is essentially an air-oil-gas process in which partial combustion of the oil with air takes place within the retort, thus supplying internally the heat necessary for the thermal decomposition of the hydrocarbons. The need for external heating is thereby minimised. The nitrogen of the air used is, of course, present in the gas made, which may be of various grades. It is stated that approximately 4 gallons of fuel or gas oil is required for the production of 1000 cu. ft. of 450 B.Th.U. gas. A statement which would require very serious examination before acceptance is that "theoretically it has been found, and under practical conditions of industrial operation it has been proved, that Dayton gas of 450 B.Th.U. per cu. ft. is required in no greater *volume* than illuminating gas of 630 B.Th.U. per cu. ft. for the same work." The metal retorts used seem to undergo rather drastic treatment, and it would be interesting to know their length of life.

The chapter on "Surface Combustion," by Mr. A. E. Blake, reports mainly progress obtained with the impact type of burner, and is followed by one on the "Future of the Artificial Gas Industry," and by others of a general character, such as "Fuel Conservation," and "Some Problems in the Utilisation of Fuel," both these making interesting reading. An appendix deals with methods for the analysis of coal and fuel oils.

The book is well printed and generously illustrated throughout. It is certain to be very useful, not only in America but also in other countries, particularly if read with the discrimination suggested above.

John W. Cobb.

The Teaching of the Calculus.

Common Sense of the Calculus. By G. W. Brewster. Pp. 62. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 2*s.* net.

From time to time in recent years, small books have appeared which would be more or less correctly describable under the title "How Not to Teach the Calculus." We are sorry to find the present volume to be no exception to this rule, at least in its methods of treatment of infinitesimals.

Its main peculiarity is the way "quantities of the second order" crop up continually, and the way in which readers are led to believe that it does not matter much whether these are put in or left out. The main advantage of this kind of treatment is that students who have neglected their class-work and absorbed such a book for their examination are easily detected by their examiner, as they are certain to do something against which they were warned in class.

If we take $y=x^2$ and define δy as the difference between x^2 and $(x+\delta x)^2$ we undoubtedly get

$$\delta y = 2x\delta x + \delta x^2.$$

But surely it would be more in accordance with most people's ideas of common sense if instead of bringing in the notion of "second order quantities" the author had pointed out that this δy represents the change taking place in the value of the square in an interval which *begins* with the value of x and continues for a distance δx *beyond* that value. It would also surely be easier for a student to see that the *greater* the interval δx the more does this variation fail to give a correct idea of the manner in which the function was varying round about the instant that it passed the value x. Also, as the term δx^2 *increases* in relative importance when δx is made *larger*, it would not be difficult for a reader to infer that this squared difference represents the *error* introduced by measuring the change in a *finite* interval situated all on *one side of* the value x.

In fact, instead of being small quantities which may be included or omitted in this way, these "second order quantities" are really rather of the nature of *errors* which *must* be taken off if we wish to study a continuous process closely at every instant. For example, they represent the correction that would have to be applied to obtain the velocity of a train *at* any instant from the average velocity in an interval of one, two, or more seconds *after* that instant.

Now, it is customary among mathematicians to use δx to denote a finite variation in which second-order quantities may be involved, and dx to denote the limiting form. But Mr. Brewster in his preface says, "The difference between any two values of x is an easy idea to grasp, and the use of δx or dx (it does not matter much which) emphasises the fundamental meaning of a differential." . . . "My advice would be to regard dx and δx as the same thing provided δx is taken very small, and to be satisfied with a common-sense explanation of the omission of terms of the second order." And on p. 23, speaking of dy/dx and $\delta y/\delta x$, he says, "You can get on quite well without bothering to distinguish between the two."

Again, surely it would be more in accordance with common sense if some account were also taken of what happens to a function *before* the variable reaches the given value x, and if this were done with the function x^2 we should get a second value of the variation, say

$$\delta^1 y = 2x\delta x - \delta x^2.$$

The differential equation $dy=2xdx$ has now a precise meaning, as it describes a variation which always lies intermediate between the first and second estimates, however small the interval δx. As a matter of fact, fluctuations in statistics, such as increases of population, rise or fall of stock exchange quotations, *are* always and *must* always be estimated by comparing the value on any day or year with a *previous* value.

The same mistake is made in dealing with integration as applied, for example, to areas. Mr. Brewster's figures replace the actual area of a curve by a series of rectangles the *left-hand* sides of which are ordinates of the curve. Why does he not try taking the right-hand sides as well? If he would only shove his rectangles one space to the left, taking off the first and adding one at the end, he would have spared all his arguments by showing that the true area lies between two limits the difference of which can be made as small as we like by making the slices thin enough.

There is undoubtedly a great demand for a book that will introduce the notions of a differential coefficient and an integral and illustrate them with applications not involving any other functions than series of positive integral powers. So far as relates to selection of subject matter in the form of examples and applications, "Common Sense of the Calculus" exactly meets the case. We should be glad if Mr. Brewster would republish this collection based on a different method of dealing with infinitesimals. He would probably find that instead of making his book larger it would be possible even to make it *smaller*. The "terms of second order" which give so much trouble in this treatment can be got rid of completely by adopting the definition of "limiting equality" mentioned in a letter to NATURE of February 10, as the interpretation of such formulæ as $dy=f^1(x)dx$. "Zero" is a dangerous quantity to put in the hands of a beginner, and so are quantities which "may be neglected," and it was only a year ago that we had a student trying to take mathematical honours who said that two quantities da and db were "of the same order, therefore they are equal"! On the other hand, we have found it possible to condense into five or six pages of stencilled notes all the information required to explain differentiation and integration and to introduce such differentials as dx, dy, ds, dr, $rd\theta$, $\frac{1}{2}r^2d\theta$, and even $dx\,dy$ and $dx\,dy\,dz$ in a form in which finite quotients and sums of products can be built up in perfect safety, second-order quantities being tabooed, but $ds^2=dx^2+dy^2=dr^2+(rd\theta)^2$ being legitimate. A recent paper by Prof. Alfred Lodge in the *Mathematical Gazette* evidently is based on the same principle.

G. H. B.

Christopher Wren and the Tom Tower.

"*Tom Tower,*" *Christ Church, Oxford. Some Letters of Sr Christopher Wren to John Fell, Bishop of Oxford.* Hitherto Unpublished. Now set forth and Annotated by W. Douglas Caröe; with a chapter by Prof. H. H. Turner, and another by Arthur Cochrane. Pp. xii + 127 + 28 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 25*s*. net.

THIS book was published in honour of the bicentenary of Wren's death on February 25. The author had been called upon to direct some necessary repairs to the buildings of Christ Church College, particularly to the "Tom Tower," when his attention was directed to some unpublished letters and documents dealing with the original design and building of the tower, and these have now been published in the present volume. In addition to a contemporary copy of the contract between the College treasurer and the contractor for the building of the tower, there are seven autograph letters written by Wren to John Fell, Bishop of Oxford, the first dated May 26, 1681, and the last September 9, 1682, when the work was nearing completion. The last letter is reproduced in facsimile, showing Wren's firm and very distinct handwriting.

An analysis of each letter follows, and Prof. H. H. Turner has supplied a commentary to the sixth and most interesting one. This letter (dated from Whitehall, December 3, 1681) is a reply to a proposal on the part of the bishop, that the tower should be converted into an observatory. Wren is too polite to reject the proposal altogether, but gives good reasons why it should not be hastily adopted. It would involve a change in the whole design; the bell would have to be lowered so as to heighten the loft, and it might then not be well heard. The Gothic roof, agreeing with the rest of the College buildings, would have to be abandoned, and a flat roof with a horizontal balustrade substituted, while instead of windows there would have to be wooden shutters without mullions or bars. In addition to these objections from the point of view of an architect, Wren next produces others from the point of view of an astronomer, and here also he could speak with authority, having held the office of Savilian professor of astronomy for twelve years (1661–73) until pressure of other work obliged him to relinquish it.

"Give me leave to add that such a room as this will be when built, is no way necessary for observations, as now they are managed. Were I to set up the Trade again I was once well acquainted with, and I think the world doth or may justly own some improvements of it to me, I should require nothing else but these things. First a large mural quadrant fixt to a wall truly built in the meridian, and this is best in an open court or garden, 2dly a pole to raise large telescopes and manage them, and the like place is properest for this also. 3dly a quadrant to take distances fixt to a foot so as it may turn to all sort of planes . . . must be housed for its better preservation, but the best house will be a little house of boards and no other roof but what may be taken quite off when the instrument is used. . . . We built indeed an Observatory at Greenwich not unlike what your tower will prove, it was for the Observators habitation and a little for pomp; it is the instruments in the court after the manner I have described which are used, the room keeps the clocks and the instruments that are laid by."

This statement as to what an observatory ought to be like is very interesting, as showing that Wren thoroughly agreed with Flamsteed about the requirements of practical astronomy. Therefore Oxford did not get an observatory on this occasion (there were only two University Observatories in existence at that time, at Copenhagen and at Leyden), and nearly a hundred years had to pass, before the Radcliffe Observatory was built, including a very big tower!

Mr. Caröe devotes a chapter to "Wren and Greenwich Observatory," but the contents are nearly all taken from Baily's book on Flamsteed. That Wren designed the Octagon room seems certain, but he had nothing else to do with the building or the equipment of the Observatory. This chapter is illustrated by two plates giving most interesting views of the buildings and of the interior of the Octagon room, copied from some old engravings given by Baily to the Royal Observatory. It seems, however, very doubtful whether the telescope for observing sun-spots by projection and the large quadrant (Plate XXI.) can have been at Greenwich in Wren's time; at least it is not likely that the quadrant is the 10-foot quadrant made by Hooke and declared by Flamsteed to be useless. But if Wren had been able to devote some of his time to astronomy, he would doubtless have made his mark in that science. It should not be forgotten (we have not found it mentioned in the book under review) that Wren (as well as Hooke and Halley) had realised independently of Newton, that attraction if it existed must be according to the law of the inverse square of the distance, and this was expressly acknowledged by Newton (Princ. lib. I. Prop. IV. Scholium). The silly and slanderous accusation of plagiarism made by Hearne the antiquary against Newton, in favour of Hooke and Wren, should not have been quoted by the author (p. 11) without comment.

The book is beautifully and most profusely illustrated and will appeal to many different classes of readers.

J. L. E. D.

The Future of Arctic Lands.

The Northward Course of Empire. By Vilhjalmar Stefansson. Pp. xx + 274 + 8 plates. (London and Sydney: G. G. Harrap and Co. Ltd., 1922.) 7*s.* 6*d.* net.

MR. STEFANSSON shows, with characteristic force of expression and wealth of example, that every effort to colonise the frontiers of the familiar world has been retarded by fear bred of ignorance. He regards the popular repute of the Arctic regions as a survival of the ancient shrinking of the Mediterranean peoples from cold and darkness, intensified by tales of the sufferings of explorers, which he holds to have been partly unnecessary and partly exaggerated. On the other hand, he shows that throughout the whole history of civilisation the centres of political power of the most advanced races have undergone a steady displacement northward from the neighbourhood of the tropic. He holds that this migration of the dominant races is accompanied by an increase in physical and mental vigour, and he would perhaps be inclined to agree with Richard Chenevix's bold generalisation of ninety years ago, that character is expressible as a mathematical function of latitude.

Mr. Stefansson indicates that the natural northward course of civilisation is now being held up by a superstitious tradition maintained by faulty educational works based on misleading narratives of polar travel. He insists on the fact that Montana, Dakota, and Manitoba are far colder in winter than the low-lying coasts and islands of the Arctic Sea or the North Pole itself. Yet in these far severer climates children go to school daily in temperatures that a polar explorer is very rarely called upon to encounter, so that cold need not deter a sturdy people from moving north.

The main object of the book is to combat this specific ignorance of polar conditions, and Mr. Stefansson enters on the struggle with Berserk gusto. He firmly believes that, even after the mineral resources of Arctic lands—*e.g.* the gold, coal, copper, iron, and oil of Alaska and Northern Canada—have been exhausted or have at least lost their sensational attractive power, there remains a vaster and more permanent source of wealth for the outer world to draw upon in the incredible richness of millions of square miles of Arctic meadows. These are grazed over by herds of reindeer and ovibos, capable of forming the basis of the largest meat and wool production the world has ever seen. In fact, the author goes so far as to hold that Arctic meat alone can furnish a safeguard against famine on an unheard-of scale when the population of the world has doubled itself a century hence.

The facts cited as to the growth of reindeer herds in Alaska, and the popularity of reindeer flesh in large cities, are most impressive, and the prospects of the Hudson Bay Company's experiment in rearing the ovibos (its old name of musk ox is banned) in Baffin Land appear to be extremely favourable. Mr. Stefansson points out that the failure of farmers in northern lands has almost always been due to their attempts to introduce plants and animals natural to southern localities, whereas success as surely attends their efforts when they devote their attention to those native to the climate.

An interesting chapter is devoted to the prospects of Polar travel by aircraft and submarines, and it would almost appear that the adventures of Capt. Nemo under the ice in Jules Verne's old story were coming true. Mr. Stefansson is usually careful to base his calculations and projects on established facts and the opinion of experts; but we fear that in one point he has failed to do so, and we cannot accept his prediction on p. 186, that "ordinary tramp steamers" can ever navigate the ice-encumbered Arctic waters. Mr. Stefansson wants to provoke controversy and inquiry with regard to the grounds of his faith in the future of the North, and the vigour, resourcefulness, and good humour of his propaganda should make even his critics his friends, for every one likes a strong man in pursuit of a great idea. HUGH ROBERT MILL.

Our Bookshelf.

Occultism and Modern Science. By Prof. T. Konstantin Oesterreich. Translated from the second German edition. Pp. vii + 181. (London: Methuen and Co., Ltd., 1923.) 6*s*. net.

PROF. OESTERREICH's book is intended to be a popular presentation to the German public of the evidences of "occult" phenomena, which are fairly well known to English-speaking people. He points out that this field of knowledge has been little cultivated in Germany, and, with great impartiality, places such facts as have been observed before his readers. He examines the cases of Helene Smith, Mrs. Piper, Palladino, and Eva C. in detail, and arranges his phenomena under the heads of states of impersonation, psychometry, cross-correspondence, telekinesis, and materialisation. His conclusions are adverse to spiritism; but, on the evidence, he seems to have no doubt of the occurrence of the phenomena in question, though there is no indication in the book of any first-hand acquaintance with the subject. Indeed, there is a lack of judicial balance in the admission of the evidence. Crawford—though the facts were clearly not known to Oesterreich when this work was written—is cited as an authority for telekinesis and materialisation. The introduction is remarkably good, as is the general plea for scientific examination without prejudice of the facts; but the chapter on theosophy has little connexion with the rest of the book, and rather marrs it by the personal note with regard to Rudolf Steiner which it introduces.

Department of Scientific and Industrial Research: Food Investigation Board. Special Report No. 15 *by the Engineering Committee of the Board. Insulated and Refrigerator Barges for the Carriage of Perishable Foods.* Pp. iii + 21. (London: H.M. Stationery Office, 1923.) 1*s*. net.

WHILE in normal circumstances the barges thermally insulated with four inches of cork at present used in Great Britain for the conveyance of perishable food such as frozen meat from the importing ship to the quay or cold store are found to be adequate, conditions arise in practice under which they fail. This report will serve as a valuable guide to those who wish to provide something better. It is shown that the ordinary insulated barge is only satisfactory for 48 hours if the frozen cargo is well packed, so that its rise of temperature owing to its having to cool the barge may be as small as possible, and if the temperature of air and water do not exceed 50° F. If the barge can be pre-cooled to 20° F. it is adequate under the same temperature conditions for 96 hours. If the temperature of air and sea water rises above 70° F., the barge, even when pre-cooled to 20° F., will only prove effective for about 40 hours, and if it is to carry its cargo longer it must be provided with refrigerating machinery. In one experiment with a barge so equipped a cargo of frozen meat was carried for seven days without its temperature rising more than 3° F.

Electric Transients. By Prof. C. E. Magnusson, A. Kalin, and J. R. Tolmie. Pp. viii + 193. (New York and London: McGraw-Hill Book Co. Inc., 1922.) 12*s*. 6*d*.

THIS book was primarily written for the electrical engineering students of the University of Washington. It discusses in detail many of the transient phenomena which ensue whenever any of the electric "constants" of a circuit suddenly alters in value. Excellent oscillograms are given, the study of some of which will be of value to advanced students. As a rule, the transient quiver induced in the current wave by a sudden disturbance of the circuit dies away rapidly. In some cases, however, it attains excessive values and does damage. In a few cases it is continually in evidence, as, for example, when an electric arc forms part of the circuit. The question of "transients" therefore needs to be studied carefully by electrical engineers. The introduction is rather too condensed. For example, we are told that the Ohm's law of the dielectric circuit is that the dielectric flux equals the voltage divided by the elastance of the circuit. The elastance is the reciprocal of the condensance. The former is measured in "darafs" and the latter in farads. It is not easy to picture what the authors mean, as apparently the cross-section of the dielectric circuit is constant.

Surface Tension and Surface Energy and their Influence on Chemical Phenomena. By Dr. R. S. Willows and E. Hatschek. (Text-books of Chemical Research and Engineering.) Third edition. Pp. viii + 136. (London: J. and A. Churchill, 1923.) 6*s*. 6*d*. net.

THE study of "Surface Tension" has been modified profoundly by the conception of oriented molecules which was introduced by Langmuir in 1917, and has since been developed on a rigid quantitative basis by the researches of N. K. Adam. These new developments are described and discussed in the new edition of this work. The fact that the subject is treated from the physical rather than the chemical point of view increases the value of the book as a contribution to physical chemistry, since it leads to the introduction of information which is not usually available in books written by chemists.

Intelligence Tests and School Reorganization. By Lewis M. Terman and others. Prepared as a Subcommittee Report to the Commission on Revision of Elementary Education, National Education Association. Pp. viii + 111. (London, Calcutta, and Sydney: G. G. Harrap and Co., Ltd., n.d.) 4*s*. 6*d*. net.

A USEFUL little set of monographs on the use of intelligence tests. Chapter 3—"Methods of Individual Instruction in the Adjustment Rooms of Los Angeles"—by A. H. Sutherland, is perhaps the most valuable, as indicating a means of securing the incentive of personal interest in acquiring information in the case of backward children.

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.]*

Dr. Kammerer's Experiments.

As I had the privilege of entertaining Dr. Kammerer in my house when he was passing through London, and of discussing his experiments with him, and as I acted as his interpreter when he replied to his critics at the meeting of the Linnean Society, space may be permitted me in which to reply to the criticisms of Mr. Cunningham which appeared in NATURE of May 26, and to those of Dr. Bateson in the issue of June 2.

I will deal with Dr. Bateson's remarks first. From his speech at the Linnean Society I gathered that Dr. Bateson completely withdrew his charges of bad faith on the part of Dr. Kammerer, and accepted his published results as genuine, claiming, however—as he had the full right to do—to differ from the deductions which Dr. Kammerer drew from them. But Dr. Bateson's letter reads like a prolonged imputation of fraud to Kammerer; he refers to Dr. Kammerer's illustrations as like "spirit photographs," and demands further evidence before he will base any conclusions on Dr. Kammerer's work. Now, Dr. Kammerer explained at the meeting that the specimens shown by him constituted the salvage of the utter wreck of the experimental laboratories at Vienna owing to the War. His work has been going on since 1900—the year in which, unless I am mistaken, Dr. Bateson began his Mendelian work—and, in my opinion, the work has yielded results which are of as much importance in the study of heredity, from the evolutionary point of view, as all the Mendelian experiments together.

The main point in Dr. Bateson's letter is, however, that the specimen of Alytes shown by Dr. Kammerer to the Linnean Society did not show a typical "nuptial pad" (*Brunstschwiele*), and that the alleged pad was in the wrong place, because it was only the back of the hand which came in contact with the body of the female, so that the rugosities should be there and not on the palm; further, that a typical nuptial pad showed papillæ, and that he could not see them in the specimen. In proof of his assertion that the normal contact between male and female takes place with the dorsal surface of the male hand, Dr. Bateson publishes a print from a photograph of a pair of *Rana agilis* killed in the nuptial embrace. I ought to add that he was kind enough to send me privately a positive of this photograph, which shows his point more clearly than the print in NATURE.

Let us deal first with the structure of the horny patch. Dr. Bateson omits to say that at the meeting a section through one of these patches was shown under the microscope, and that, when the point of structure was raised in the discussion, Dr. Kammerer thought it too frivolous to reply to; he merely referred to the section which he had exhibited as answer. Dr. Kammerer, who has cut sections of the nuptial pads of all our common Anura, and can detect the species by the appearances shown by the microscopic preparation, assumed a similar knowledge on the part of his audience—but, to judge from Dr. Bateson's letter, he was rash in doing so. I have, however, taken the trouble to refer to Lataste's original figures of the callosities ("Mémoire sur les brosses copulatrices des batrachiens anoures," *Annales des Sciences naturelles*, 6me series, vol. 3, 1876), and I have no hesitation in saying that the section shown in the Linnean Society displays almost exactly the same appearances as those figured by Lataste in the figure of a section through the nuptial pad of the closely allied genus Pelodytes. Further, I have had sections through the nuptial pad of *Rana temporaria* prepared in my laboratory, and I can see in them the same structures as were shown in Dr. Kammerer's slide; of course, in Rana, as Lataste's figures show, the papillæ are very strongly developed—much more so than in Pelodytes or Alytes—but the essential structure is the same. The pad in Rana, to the naked eye, looks like a simple patch of pigment, and passing my finger over it I could not detect the papillæ by feeling.

As to the position of the pad, Dr. Bateson seems to think that he has settled this question *for all Anura* by his photograph. Now Alytes belongs to the small family of the Discoglossidæ, probably the most primitive family of the Anura. This family includes, besides Alytes, the genera Discoglossus, Bombinator, Pelodytes, and Pelobates. Boulenger, in his monograph, "The Tail-less Batrachians of Europe" (Ray Society, 1897), gives details of the position of the pads:

(1) Pelodytes, on the *inner side* of the two inner fingers—the antibrachium, the brachium.

(2) Discoglossus, on the *inner* and upper side of the three inner fingers.

(3) Bombinator, on the *inner* side of the three inner fingers and the antibrachium.

(4) Pelobates, copulatory excrescences absent.

The fact is that the primary contact between male and female takes place neither with the dorsal nor the ventral surface of the hand, but with the *radial edge*, and this is in accordance with Dr. Kammerer's experience; for in Alytes the pad first appears here, as shown in Dr. Kammerer's figures[1] (those criticised by Dr. Bateson in NATURE of July 3, 1919), and only later extends to the other fingers. In tight embrace, as indeed Dr. Bateson's photograph shows, the hand of the male becomes embedded in a fold of the female's body, and it is then a question of the direction in which pressure is exerted whether the additional callosities will appear on the inner or on the upper sides of the fingers. Perhaps I may add that the specimen shown in the Linnean Society had been previously exhibited at Cambridge, where it was inspected by Dr. Gadow, probably the best herpetologist at present living in Britain.

Dr. Gadow raised none of Dr. Bateson's objections, but he added the extremely interesting information that in the Portuguese species, *Alytes cisternasii*, old males occasionally develop callosities on the tips of the two inner fingers.

Dr. Bateson refers to Dr. Kammerer's reply "as disquieting to his disciples," since Dr. Kammerer stated that he did not regard the nuptial pad as an adaptation. I fear that my translation of the reply must have been singularly defective if Dr. Bateson drew any such conclusion. Dr. Kammerer's reply was that while, of course, the pad in Alytes was the revival of an ancestral nuptial pad, he had not made up his mind with certainty as to the *stimulus* which had revived it (*i.e* whether it was pairing in water or the contact with the female). He did not allude to the stimulus in his lecture, and only with caution and reserve in his paper. The tight embrace necessary to hold a slippery partner seems to me,

[1] After consulting with Dr. Kammerer, it is obvious to me that Dr. Bateson mistook a patch of dirt adhering to the fourth finger of the specimen shown in these figures for the pad.

however, as it does to Dr. Kammerer, the most likely explanation; and as the male is frequently smaller than the female, this may lead to a deeper embedding of his hand in her flank and a larger area of contact, and thus to an extension of the callosities.

Since the pad only appears on males in the third generation after they have begun to pair in water, and then in the same place as it appears in Pelodytes and Bombinator, to suggest that it is not a functional adaptation but a chance mutation throws a singular light on what I may term the constitution of the Mendelian mind.

Turning now to Mr. Cunningham's letter in NATURE of May 26, I find that he criticises Dr. Kammerer's experiments on Salamander and Ciona. Taking his remarks on Salamander first, he has misunderstood Dr. Kammerer's reference to the ovary of the Salamander as being enclosed in a membrane, while that of the bird is not. It really does not assist in the controversy for Mr. Cunningham to accuse Dr. Kammerer of childish mistakes which would disgrace a first-year student in biology. Translating Dr. Kammerer's statement into modern technical language, it reads thus: "The ovary of the Salamander is completely invested by peritoneum and suspended to the back by a mesentery" (a fact which I have verified), "whereas the ovary of a bird is covered only on its ventral surface by peritoneum and is largely retroperitoneal, and therefore more difficult to remove in its entirety."

Next, Mr. Cunningham refers to Dr. Kammerer's Mendelian experiments with naturally and artificially striped Salamanders and the "forma typica." It is indeed disquieting to find so sound a Lamarckian as Mr. Cunningham so much under the influence of what I may term Mendelian dogmatism as to suggest that because the artificially-striped Salamander does not "Mendelise" when crossed with "typica," therefore the character is not gametic or hereditary! Truly a vicious circle of thought: the test as to whether a character is hereditary or not is surely whether or not it can be transmitted to the offspring.

I agree with Mr. Cunningham that Dr. Kammerer's results in Mendelising and in ovarian transplantation are extremely unexpected, and I may add that Dr. Kammerer himself did not expect them, and frankly admits that he has been unable to frame an explanation for them which is satisfactory to himself. I will not waste space by attempting to suggest an explanation, but I will refer Mr. Cunningham to Dr. Kammerer's long paper, where full details are given. I think he will find that the results are such that it would be difficult for mistakes to be made, and therefore, unless Dr. Kammerer is to be charged with deliberate bad faith, they must be accepted.

Dr. Kammerer regarded his experiments on Ciona as affording the clearest proofs of the inheritance of acquired characters. He showed photographs of his results. Mr. Cunningham objects that no photographs of the controls, *i.e.* of ordinary adult specimens of Ciona, were shown, in spite of the fact that Dr. Kammerer stated at the meeting that the experiment had been conducted on 100 specimens, and that, of course, controls had been made—that, indeed, the establishment of controls was the A B C of experimental science. I think that Mr. Cunningham, on reflection, will see that by this attitude he is joining the ranks of those who seek to escape from the inevitable deductions to be drawn from Dr. Kammerer's results by accusing him of deception, and this is an attitude with which none of us who had the pleasure of meeting Dr. Kammerer and seeing his specimens and discussing matters with him would have any sympathy.

E. W. MACBRIDE.

Law governing the Connexion between the Number of Particles and their Diameters in grinding Crushed Sand.

THE discovery of a simple law relating to continuity of particle size in fine grinding (or the breaking up larger into smaller particles) has long been a matter of scientific and technical importance. By means of experiments extending over some years, the British Portland Cement Research Association has definitely ascertained that, so far as a crystalline substance such as "standard sand" is concerned, a definite law does undoubtedly exist, which may be defined mathematically as follows:

In a given weight of W of finely crushed sand, if N be the number of particles of diameter x and if N and x be considered as variables, then in every case so far tested

$$N = ae^{-bx}, \qquad (1)$$

where a and b are two constants characteristic of the particular sample tested.

Differentiating (1) we obtain:

$$\frac{dN}{dx} = -b \,.\, ae^{-bx} = -b \,.\, N. \qquad (2)$$

In other words, *the rate of increase with decrease of diameter, of the number of particles present of any given size is proportional to the number of particles of that size.*

It is therefore possible to calculate the number of particles of any given diameter without going through the laborious process of sieving.

Another result of this law is that it now becomes possible to calculate exactly the theoretical amount of work required to produce powders of different degrees of fineness, and in that way do for the art of grinding what has long since been done for steam and electricity, namely, reduce grinding to an exact mechanical science. In other words, just as the engineer knows the amount of electrical energy or steam necessary to perform a given amount of work under definite conditions, so also he will in future be able to estimate the amount of work required to reduce a given material to a given degree of fineness under given conditions. It will thus be possible to deduce the efficiency of any grinding machine. These and other matters will be gone into in a paper now in preparation, in which the experimental details will be fully described.

The physical significance of this law is simple.

Consider a set of sand particles A (Fig. 1). By *grinding*, *each* of the particles A gives rise to the same number k (in our illustration $k = 2$) of smaller particles B, each of which in its turn gives rise to the same number k of still smaller particles C, and so on *all down the scale so far as we can pursue the matter by means of the microscope, with the ultimate production of colloidal particles.*

The law is probably the expression of the fact that crystals have a definite and fixed structure, and consequently break up when subjected to percussion or pressure in a regular and definite manner, which follows a definite mathematical law when the number of particles considered are sufficiently numerous to allow of the application of the law of probability.

The subject is of great scientific interest. For example, there is an obvious thermodynamical connexion between the work done in grinding (*i.e.* producing small particles from large ones) and the amount of heat required theoretically to *gasify* the material. For—considering the simplest possible case—in gasifying a homogeneous solid material (without passing through the intermediate liquid state) we are merely reducing the material to particles of molecular dimensions and separated by distances beyond each other's sphere of molecular attraction. Whereas in ordinary grinding the same action is performed but the particles remain of considerable size. It follows from this that a homogeneous crystalline substance such as the diamond—which requires a large amount of heat and a high temperature to gasify—would be expected to require the expenditure of more work in reducing it to a certain fine state of division than a substance like ice (supposed kept at a temperature below freezing-point of water), which can be comparatively easily gasified.

This aspect obviously opens out a large field of research until now quite untouched; for example,

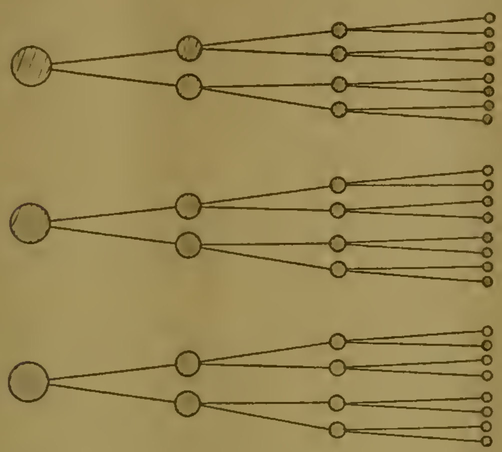

FIG. 1.

there exists a large number of organic crystalline compounds of which the heats of volatilisation are known, and the action of which under percussion or pressure could be investigated from this point of view.

The research work carried out has already proceeded sufficiently far to allow one to hope that in the near future the art of "grinding" will be transferred from its present chaotic state of empiricism into that of an exact science. The importance of this development in the gold-mining, pigment, and other industries—which depend so largely upon the production of materials in a state of fine division—will be apparent when we reflect on the great advances which occurred in the electrical and steam engineering sciences when the underlying laws were worked out.

CHARLES E. BLYTH.
GEOFFREY MARTIN.
HAROLD TONGUE.
The British Portland Cement Research Association,
Rosherville Court, Burch Road, Gravesend,
May 30.

Adsorption and Hæmoglobin.

ONE fundamental difficulty in the hypothesis that oxygen and carbon monoxide are "adsorbed" by hæmoglobin lies in the highly specific nature of the absorption spectrum of the compounds so formed. The change in colour of reduced blood, or of a dilute solution of reduced hæmoglobin, when shaken with air or oxygen, is very obvious to the naked eye, as also is the change when the oxygen is replaced by carbon monoxide. These colour changes can be used, either as in Haldane's method with direct vision, or as in Hartridge's by the spectroscope, for the exact quantitative measurement of the amount of gas taken up. Such remarkable, definite, and highly specific changes in the absorption spectra have no parallel, so far as I am aware, in any well-authenticated case of adsorption (unless the phenomena of electrolytic dissociation be classed as such), and must be explained by any theory, as of course they are by that of a specific chemical change in the nature of hæmoglobin by its combination with gas.

Sir William Bayliss, in his letter to NATURE of May 19, p. 666, and elsewhere, argues that the "widely divergent results obtained by different investigators of the heat of combination between oxygen and hæmoglobin" have not been adequately explained. The explanation really is simple, experimental error. If the solutions, or the blood, be reasonably aseptic, if due attention be paid to the carbon dioxide driven off when oxygen passes in, and if the observations be made with sufficient care and criticism, divergent results are *not* obtained. Any theory can be confused by imperfect experiments.

Again, Sir William Bayliss states that "in connexion with the relations between hæmoglobin and carbon dioxide, no proof has yet been given that the union is of a different nature from that with oxygen." Several such proofs exist: (*a*) it can be shown that nearly all, if not all, of the CO_2 taken up by blood at small CO_2 pressures (*i.e.* within the "physiological" range) exists there as actual bicarbonate (HCO'_3) ions; no other reasonable explanation is possible of the manner in which the hydrogen ion concentration of blood varies with CO_2 pressure; (*b*) the reaction of blood with CO_2, over the same range of CO_2 pressures, produces no change whatever in its absorption spectrum; (*c*) as the CO_2 pressure is increased the amount of CO_2 taken up does not approach a maximum in the same definite manner as does the amount of oxygen when the pressure of the latter is increased; neither is there any such precise relation between the Fe and the CO_2 as between the Fe and the O_2 or CO; (*d*) the effect of CO_2 on the hæmoglobin-CO reaction is precisely equal to that of a change of hydrogen ion concentration, exactly equal to that produced by the CO_2 but set up by another acid, such as HCl; in other words, the total effect of CO_2 on the hæmoglobin-CO reaction is exactly equal to that due to its acid character, which leaves no margin at all for any specific effect of CO_2 in turning out CO; in contrast to this, the considerable effect of oxygen on the same reaction is certainly not due to any change of hydrogen ion concentration produced by the oxygen, for (provided the hæmoglobin be kept saturated with CO and O_2) this change is *nil*; (*e*) the effects (i.) of oxygen and (ii.) of CO_2 on the combination of hæmoglobin with carbon monoxide are quantitatively quite different; (*f*) the effects of carbon monoxide on the reactions of hæmoglobin (i.) with oxygen and (ii.) with CO_2 are also different.

Sir William Bayliss affirms that "sometimes . . . workers are so convinced that the mass action view is all that is necessary, that they are not interested in testing the truth of the assumption." I can assure him that at least ten active workers of my personal acquaintance are "sometimes" very much interested, and indeed have recently applied the most stringent and searching tests to the view that the combinations of hæmoglobin with oxygen and carbon monoxide are in the ordinary sense of the word, chemical, and obey the usual laws of chemistry. The accepted manner of "testing the truth of an assumption" is to make theoretical (and preferably quantitative) deductions from it, and then to see if, and how far, these deductions are verified experimentally. This is being done repeatedly with the chemical theory of the dynamics and statics of the hæmoglobin reactions. If only those who believe in the adsorption theory would make some precise deductions from their theory, it would be easy to test that also. At present it evades any quantitative trial.

Attempts have been made to apply the Phase Rule, and to attribute the properties of large-scale matter to the single ultimate unit of hæmoglobin as it exists in solution. Presumably this ultimate unit has a diameter about 10 times that of the oxygen molecule; it is presumably in violent, oscillatory (thermal) movement; there is no good evidence that it has ever been observed with the ultramicroscope. To regard it therefore as a separate phase is to disregard the statistical basis of the Second Law from which the Phase Rule is deduced. *If* the hæmoglobin unit be indeed a separate phase, then admittedly the known number of degrees of freedom of the hæmoglobin-oxygen system prohibits the possibility of regarding oxy- and reduced hæmoglobin as separate chemical compounds. No evidence, however, can be given for the existence of hæmoglobin, in solution in water, as a phase separate from the water, except that it can be precipitated by various violent means—which surely is not evidence; the separate phase is a pure hypothesis and must be judged by its fruits, which at present are difficult to discern.

Sir William Bayliss's attitude of continual and friendly scepticism, on this particular subject, has had one important and valuable effect, the effect which he set out to achieve, which, however, his modesty prevents him acknowledging, or possibly even from appreciating. It has urged a number of workers to produce, what was badly needed, a body of sound quantitative experimental evidence on one of the most fascinating problems in the borderland between biology and chemistry. The evidence is not complete and we cannot convince him yet; but if he will only maintain his scepticism, in an equally friendly way, for a few years more, he will really force us to produce all the testimony which he requires. A. V. HILL.

The University, Manchester,
May 31.

IN the recent correspondence touching the nature of the combination of hæmoglobin with oxygen, references have been made to Wo. Ostwald's adsorption theory. It may clarify the issue if I remind readers of NATURE what that theory was. Wo. Ostwald argued that the equilibrium between oxygen and hæmoglobin could be expressed by a curve based on the following equation, $X = KC^m$, where X is the amount of oxygen combined with the hæmoglobin, C the concentration of oxygen in solution, K a quantity proportional to the total mass of hæmoglobin present, and m a constant. The graphic expression of this equation must necessarily be a simple curve which is at all points concave to the abscissa. No published curve representing the equilibrium between hæmoglobin and oxygen, which has been determined experimentally, is of this character, all being more or less S-shaped, though in some cases the convex inflection is very slight.

It may seem strange that a theory should have been put forward which is at variance with the facts in so fundamental a respect. In justice to Wo. Ostwald it must be pointed out that he wrote before the experimental technique now in use had been elaborated. The most recent curves at his disposal were those of Bohr, Hasselbalch, and Krogh (for the oxygen hæmoglobin equilibrium at various CO_2 pressures). These are S-shaped in character, but at the time commanded less confidence than they deserved; I think because they were determined not as individual curves but as a surface in three dimensions, the published curves being contours. All modern work has confirmed the essential character of the curves of Bohr, Hasselbalch, and Krogh.

Finally, may I pay a tribute to the helpful nature of Sir William Bayliss's criticism (NATURE, May 19, p. 666), and suggest an extension of that help in the direction of his modifying Ostwald's theory, expanding it into an equation which would fit the facts sufficiently exactly to stimulate further research on the subject. J. BARCROFT.

Physiological Laboratory, Cambridge,
June 6.

IN his letter published in NATURE of May 19, Sir William Bayliss suggests that two cases of adsorption do not come within the definition of adsorption to which I directed attention in NATURE of April 14. These are the cases when two or more substances are adsorbed upon a surface, and when a substance is adsorbed to a thickness of several molecules. Both these cases were intended by me to be included, and I think reasonably so, with the definition that it is a case of adsorption, if the substance is taken up uniformly over the whole surface; uniformly, that is, when the scale of measurement is large compared with individual molecules. This sense of uniformity is well understood in the theory of gases, where a mixture of gases or a single gas may be said to fill space uniformly, with equal correctness. I had no intention of limiting the definition to layers only one molecule thick; indeed perhaps I may be permitted, as it is suggested that I accept Langmuir's views, to point out that the theory employed by Langmuir does not seem to me necessarily to postulate that adsorbed layers are always one molecule thick. Such a proposition could only be established by estimating the amount adsorbed on unit area and calculating the thickness of the layer in terms of known data as to the size of the molecules in every case of adsorption; it does seem to be established by the beautiful experimental work of Langmuir in many cases, but is not, I think, claimed by him to be an invariable law governing adsorption.

Sir William Bayliss says in his first paragraph that no serious attempt has been made to consider surface phenomena in the combination of oxygen and hæmoglobin, since Wo. Ostwald showed that the data of the taking up of oxygen by hæmoglobin could be expressed by the adsorption formula; but he seems to have overlooked that the *sole* argument put forward in my letter of April 14, to prove that the attraction of hæmoglobin for oxygen is a highly localised property of the hæmoglobin particle, was that the hæmoglobin is so much larger than the oxygen with which it combines that the oxygen must be attached to only a very small portion of the surface. If there were general attraction of the surface of the hæmoglobin particle for oxygen, then combination would not stop when only a small fraction was covered, but hæmoglobin would take up much more oxygen than it actually does. Surely this is a very definite attempt to consider the surfaces of the particles. It is a mistake to confuse the argument used in my letter with those based on the well-known mass-action formulæ of Barcroft and Hill; it is entirely independent of them, and essentially treats the hæmoglobin in solution as a heterogeneous system, possessing an interface; it shows that this interface is, in fact, very much too large to be satisfied by the amount of oxygen which is actually taken up at saturation, and that therefore the oxygen *must* be held by some other means than adsorption.

N. K. ADAM.

The University, Sheffield,
May 24.

Relation between Hæmoglobin-Content and Surface of Red Blood-Cells.

BÜRKER (*Archiv für die gesammte Physiologie*, cxcv., 1922, p. 516) has demonstrated that the relation between the hæmoglobin-content and the surface of a single red blood-cell is constant, whatever may be the divergencies in size and hæmoglobin-content of the blood-cells of different animals.

Taking as examples the rabbit, the chromocytes of which are of medium size, and the goat, which has very small red blood-cells, he gives the following numbers:

	Hæmoglobin-content per 100 c.c. Blood in Grams.	Number of Red Blood-cells per mm. in Millions.	Average of a Single Cell.	Surface of one Blood-cell in μ^2.[1]	Average Hæmoglobin-content per μ^2 Surface in 10^{-14} gm.
Rabbit .	11·9	5·86	20×10^{-12} gm.	68·4	27
Goat . .	10·9	13·94	$8 \cdot 10^{-12}$ gm.	25·1	29

[1] These numbers are to be multiplied by 1·09; *vide* NATURE, January 6, 1923.

Now, as is already evident from the numbers given by Abderhalden ("Lehrbuch der physiologischen Chemie"), the relation between the hæmoglobin-content of a blood-cell and its volume is also constant. In the following experiment the volume of the red blood-cells was determined by centrifugation of blood after addition of a trace of sodium fluorate.

	Hæmoglobin-content per 100 c.c. Blood in Grams.	Number of Red Blood-cells per mm. in Millions.	Average of a Single Cell.	Volume of all the Blood-cells from 5 c.c. Blood.	Hence Volume of one Blood cell in μ^3.	Relation.
Rabbit .	10·6	5·7	19×10^{-12} gm.	1·7 c.c.	60	32
Goat . .	9·6	16·3	6×10^{-12} gm.	1·5 c.c.	18·4	31

The constant is the same in both cases. How are these two results to be reconciled?

One hypothesis is that the chromocytes of the goat have not the same shape as those of the rabbit. This hypothesis, however, does not seem to be satisfactory, because microscopic examination of the red blood-cells from the rabbit and the goat does not show an important difference in form.

A second hypothesis is that the method of determining the volume of the red blood-cells by centrifugation of the blood is not trustworthy.

The difficulty may be solved if, for example, the larger cells lost more water by the centrifugal force than the smaller ones; but this does not seem very probable either.

I am specially interested in the solution of this problem, because I am studying the question as to whether the hæmoglobin is distributed about the surface of the red blood-cell in such a way that all the iron is in the position that enables it to act as a catalyser. If we calculate how much iron can be placed at the surface of one human red blood-cell, it appears that this iron can form exactly one monomolecular layer, provided that one atom of iron occupies a surface of 8×10^{-16} cm^2. If, however, all the hæmoglobin should be placed at the surface in one monomolecular layer, this surface would have to be a hundred times greater. It seems probable that the surface that governs the law of Bürker must be the surface of all the "micelles" of the hæmoglobin-solution.

First of all, however, it ought to be definitely settled whether Bürker is right, when speaking of a "Hämoglobinverteilungsgesetz."

E. GORTER.

Leyden, May 7.

A Lost Collection of Indian Sketches.

IN the *Geographical Journal* for March 1922, it is stated (p. 219) that the Indian sketches made by me could not be found. As these are numerous, quite 160, made between 1852 and 1858, some details regarding them, their value as sketches, where and how they were made, may be of interest, and may possibly assist the authorities at Scotland Yard to trace them; even the discovery of one sketch might do so. It will also show fellows of the Royal Geographical Society and others why I have so persistently directed attention to the loss.

The sketches are not a traveller's collection of the ordinary kind; they were made to illustrate the country I was in, and the work on which I was employed. I cannot take a better example than the very first, made after landing in Burma. It was a water-colour sketch of the Lake at Rangoon, from the stockade which then surrounded the Pagoda hill, in its pristine state, now known as the Royal Lakes in Dalhousie Park, its artificial state. This sketch also showed the Rangoon River and hill on which stands the Syriam Pagoda, and how greatly the delta of the Irravady differs from that of the Ganges.

The first sketches go back to 1852, the year I obtained my commission and sailed for India, round the Cape, in a small troopship of 590 tons. Landing at Calcutta after a five months' voyage, and finally going on to Burma, where I passed my nineteenth birthday, all my spare time in that country was given up to making a geological map. Burma was then practically unknown, and on being appointed A.D.C. to General T. Godwin, on tours of inspection I saw much of the country.

This work compared well with the Geological map of Pegu as surveyed some years after by Messrs. W. Theobald, W. T. Blanford, and Feddon, only they were able to put an age to the formations seen; beyond knowing that the limestone of Akouk-thoung was very much the oldest, I could not. It was good practice, and many years after when I was surveying Manipur the knowledge gained was of immense value.

I must explain why when so young an officer I was able to do this. From an early age I had had most unusual opportunities to learn: my father was a geologist, always at work, always collecting, geological friends such as Edward Forbes always in the house. After learning surveying at Sandhurst I was able to help him to make plans near home to illustrate a paper he was writing—"On the Gravel Beds of the Valley of the Wey," Q.J. Geolog. Soc., vol. vii., 1857.

I helped to make the plan "On the Valley of the English Channel" (Q.J. Geolog. Soc., February 1850, vol. vi.), and learnt a great deal from seeing so much of the plans which finally illustrated the paper

"On the possible Extension of the Coal-measures beneath the South-Eastern part of England (Q.J. Geolog. Soc., February 1856). Among the geologists I met at home were Dr. Falconer and Thomas Oldham; they were the first friends to meet again in Calcutta in September 1852. I had read the work of the first with Lt. Cautley, R.E., and knew something of the Sivalik Formation when I crossed it at Kasauli in 1853. The 160 drawings cover a very large extent of country, which I roughly spread over thus:

1. Burma	29
2. Calcutta to Simla, via the Ganges Valley and on to Sealkote	26
3. Peshawar to Kashmir, through Hazara .	73
4. On appointment to the Trigonometrical Survey of India and joining Capt. Montgomerie .	10
5. When at Sealkote with 24th Regt. of Foot. In Sivaliks near Jammu . . .	10
6. Various at Cape of Good Hope. Historical of the time	20
Total . .	168

H. H. GODWIN-AUSTEN.

Nore, Godalming, Surrey,
April 27.

Science and Economics.

THE function of NATURE is not to expound economics or finance, but when a famous man of science uses its widely-read pages to challenge the fundamentals of the almost ubiquitous system under which humanity lives—or perishes, the humble individual who has undertaken to defend the philosophy of the system must be pardoned if a little extra space is required to try to elucidate an aspect of the subject overlooked both by would-be reformers and unreflecting conservatives.

(1) Prof. Soddy tells us now quite plainly (NATURE, May 19, p. 660) that economics should be classified as natural physical phenomena, and, in effect, that all would be well with humanity were we to reorganise our economic system according to the laws formulated by men of science from their investigations in inorganic chemistry and physics. This is, if I may say so, a purely theoretical conception that is not substantiated by experiment or experience. Prof. Soddy lays stress on the physical aspect of phenomena. I had thought that scientific investigators had ceased to view any natural phenomenon as purely physical. However, that is perhaps only a matter of definition; but granting his terminology, I cannot agree that it is, or ever could be, possible to apply the laws of physical nature to the activities of mankind. Inorganic nature appears to be a finished product, since the laws of its atomic systems are unalterable by human means. Humanity, on the other hand, is obviously "in the making," and the doctrines and social systems adopted in different periods are temporary expedients that assist its evolution and correspond to the stage reached at any given time. As an Eastern proverb says, "The gods of one age become the devils of a succeeding age." Now, this makes life interesting and gives us all something to do. If mankind were to be reconstituted as is inorganic nature, instead of being organised as it is, those of us who now form theories and opinions and exercise our minds would be without occupation, if we had not shaken the dust of this dull world from our arrogant heads and departed to conquer other worlds.

Seriously, "economics" describes a human method; it is not a natural science and, hence, cannot be exact. There is an element in man not governed by the laws of physical nature, and this principle seeks to govern and direct them. This may imply "distorting physical nature to suit human nature," but the father of experimental science started it on the way by commanding us to "torture Nature," and thoroughly well have we obeyed him! The object of science is surely to understand Nature in order to use it for human ends. Prof. Soddy would reverse this, and advocates modelling our economic system on the laws of physical nature, a proposal tantamount to an attempt to baulk human evolution and to impose on man the rules of an inferior order of existence. Theoretically it would be easy to formulate a *fool*-proof economic system according to the laws of an atomic system; practically, any such system could not be *genius*-proof, and, certainly, if we value the evidence of history, we should be most unscientific to discount the geniuses who, ever so often, appear and alter existing conditions and methods. The "Robots" of the drama could never become a permanent feature of the human world.

(2) With regard to the age of our present system, it is necessary to make clear the essential difference between *the financial system* and *economic methods*. The principles of the former accord with fundamental characteristics of the human race; the methods of the latter are adjusted to changing environmental conditions and advancing knowledge of the resources of our planet. The essence of the financial system is, and always has been, *credit*, without which no civilisation would ever have been initiated by the trusted geniuses and leaders of the mass of mankind. I fear there is confusion in the minds of economists, both orthodox and heterodox, as to the origin and basis of credit as distinct from money and currency. Economics is a study of methods and theories. When orthodox, its laws are deduced from observations of a system at work *which it did not originate*; when heterodox, it consists of speculations, most of which are useless anachronisms, as their formulæ, like those of Karl Marx, do not take account of the fact that science is transmuting the economic basis of man's existence, which depends less and less on human physical "work," more and more on the application, direct and indirect, of "mental energy."

The financial system, on the other hand, is a principle in actual operation, and at present its methods are simply a modification of a tradition of credit-control handed down through many civilisations. Rome, Egypt, Babylon, India, China, etc., had their financiers who controlled credit according to the accepted code of laws. Archæological investigations, for example, have produced huge vaults of Babylonian cylinders containing the records of the accounts of banking concerns, their debts and credits. It would be naïve to imagine that the personal and commercial intercourse between the peoples of earlier civilised nations, such as Greece and Rome, was conducted on a cash basis without the assistance of credit. When a boy could be sent from Greece to school in Rome with a note to his father's banker in that city to pay his school expenses it is apparent that the credit-system was in operation. The kind of currency is quite subsidiary to the principle of credit—for if the Emperor of Rome had had bone or other discs of different sizes etched with the Royal insignia and issued in amount to meet the exchange needs of his Empire, the Greek boy would have got on as well with these as with the silver, gold and copper coins he used while in the Imperial city. His father, a merchant, had a credit account in Rome, for use as and when required.

The fact that many of us are only just realising the erroneous theories the economists had formulated and taught about the intrinsic value of gold as the basis of currency, is no proof that the initiators of the financial system, whoever they may have been, laboured under the same absurd delusion. The reasons why a particular kind of currency came into use are fairly obvious to any one who has thought about it in relation to different stages of civilisation and human development. The problem of counterfeit money has also to be considered in this connexion. Our present system is an evolution of the Italian banking system bequeathed to that nation from a former civilisation. Since the founding of the Bank of England in 1694, industry and the financial system have expanded together on the basis of personal integrity and national credit. The fundamental principle of the system has never changed as far back as we can trace it into the remote past. It is founded on the permanent principle in human nature described as *a sense of responsibility* (individuality) and *a desire for action* (progress and evolution), and it is this which has guided the granting of credit and the use of a nation's currency. Individuals who obtain the use of the community's credit at any time are those who are able to produce what mankind desires, or is taught to desire, whether goods, ideas or adventures. It is a fact that gold alone did not finance the first factories erected and operated mechanically in this country, and credit has been issued ever since in increasing amounts on the basis of the ability of industrial concerns to produce what men desire to consume.

(3) Prof. Soddy says of the financial system that "Such a system as the present has never even been attempted before." This is not correct, as I have tried to indicate briefly above. He says, further, that "It is an absolute innovation." An *absolute* innovation is impossible under the laws of evolution and is not known in all the annals of human history, with the single exception of revolution, which is always followed by a restoration of tradition in a modified form. But the innovation here referred to is evidently the alteration in the class of persons to whom credit was granted after the introduction of mechanical power. It appears to have been a fundamental innovation because mankind then entered upon a new stage of evolution under new economic methods and new incentives and desires; and, therefore, the ostensible basis of credit was gradually transferred from land to the more productive industrial plant. The use of mechanical energy made it possible to satisfy growing desires, and the financial adaptation took place naturally as an "inflation" of currency necessary for the distribution of the increased products. This was not a fundamental change in the financial system as such; it was a change in economic methods: a new form or symbol of credit came into use.

The century or more since then has afforded ample time for the evolutionary process to complete the cycle of existence of this form so that the signs of age are apparent, as I suggested in a previous communication. The reasons are obviously that—

1. Machines are becoming more and more perfect and human labour less and less necessary for the production of the means of existence.
2. Most countries, even into the East, are becoming industrialised and their products cannot be marketed abroad as readily as in the nineteenth century.
3. Credit facilities have become too concentrated in the extension of industrial production, and the desires of those devoted to learning and the fine arts have been comparatively neglected under a democratic regime.

The results of 1 and 2 will gradually operate to inaugurate a new modification in the use of credit, because a wider base, another symbol or form of credit, must be found by which the means of human evolution and of existence under new conditions can be more adequately distributed. As machines now perform so much of the world's work, an extensive "unearned" distribution of currency would be possible and would benefit the skilled staffs of industries because of the increased expenditure of the people. The "out-of-work" allowance, however, is admitted to be an undesirable method, as the recognition of the mere "right to live" is not sufficient for those who realise the responsibilities of human government. The ethical effects cannot be disregarded, and the problem in this age of transition is to find suitable occupations for certain types. The latent powers in human beings are developed by individual effort, and it is evident that the financial system and social laws were originally formed with the view of inspiring and rewarding such effort. It is in this respect that our present methods require modification, and doubtless many new, and extensions of old, occupations would suggest themselves were the standards of character and attainment different. The scholarship method of encouraging self-development and distributing currency could be extended in other directions and to other occupations, and incentives devised for human endeavour toward worthier ends than now attract the majority. But it would be unsafe to attempt a change on a wide scale until the principles which should guide the innovation are clearer.

(4) Finally, Prof. Soddy describes the present system as "counterfeit." I presume (under correction) that he has in mind the "interest" on credit-loans. The philosophy of "usury" is very interesting, as it involves the polar principle which science has demonstrated, and also the principle of growth or development which evolution implies. Interest is roughly the measure of the increased productive capacity from year to year, and this increase is returned immediately to industry as new "loans" and distributed as currency in wages, salaries and dividends, according to the ability of industry to absorb and use it. Interest or "usury" acts as an automatic regulator and indicator; it shows where the energy and desires of man are expended. It also acts as a check and restraining influence on impetuous individuals, although to economists who may not realise the polar principle of "debt" and "credit" it is rather of the nature of the red flag.

Greed and selfishness (concomitants of the evolutionary process) would be even more in evidence were human beings not automatically controlled and regulated by the laws of its own credit system, which at the same time fulfils the human function of providing for changing conditions, growing desires and the development of individuality—otherwise we might, indeed, perish. Even as things are, honest intention to meet "promises to pay" and ability to perform what this industrial age and its ideals demand (Mr. Lane Fox Pitt's "practical instruction," May 19, p. 670) underlie our credit system, and any one who has the "credulity" to evade these conditions comes sooner or later to the end of his rope and his character.

In conclusion, my object is elucidation and is not to prove any person wrong, least of all Prof. Soddy, whose courageous tilting at economic conditions has stimulated thought and will help to hasten a most urgent readjustment of methods and conditions which, in my opinion, can be brought about only by a change of ideals. W. WILSON LEISENRING.

May 22.

Separation of Isotopic Ions.

IN the issue of NATURE for June 2, p. 763, there is a reference to a paper by Kendall and Crittenden (Washington: National Academy of Sciences, vol. 9, No. 3) which describes a method for separating isotopic ions. This method was first described by Prof. F. A. Lindemann at the Royal Society conference on isotopes (March 1921). A considerable number of experiments on this subject have been carried out here during the past year, but it seemed desirable to postpone publication until a definite result had been achieved.

JOHN G. PILLEY.

Clarendon Laboratory,
University Museum, Oxford,
June 5.

Haze on Derby Day—June 6.

THERE was a dense haze overlying Southern England on June 6, becoming worse towards evening and greatly interfering with visibility. It was very marked in Surrey in the neighbourhood of Epsom, where the race-goers found it difficult to see clearly. Records of this haze taken with my dust-counter at Cheam, between 7 and 7.30 P.M., gave a greyish deposit of dust particles upon the cover-glass. These particles varied in diameter from 1½ microns down to ultra-microscopic size; the average diameter was about ½ micron. Most of them were irregular in shape and insoluble in water, but scattered among the irregular dust particles were a number of small spheres. The proportion of these spheres present was about 3 per cent. of the total number of dust particles. They were transparent and usually colourless, but some were distinctly brown or reddish. The maximum diameter of the spheres found was 1½ microns, but most of them were less than this. They were insoluble in water. The haze was unusually dense for a country district, and the number of dust particles per cubic centimetre was between 9000 and 10,000.

It will be remembered that on Derby Day there was very little wind, but what there was was from the north. It is difficult to avoid the conclusion that a large proportion of this dust travelled south from the manufacturing districts of the Midlands. The presence of coloured and colourless transparent spheres points towards ash particles ejected from chimneys, while the grey colour is not what one would expect if domestic smoke were the origin. The records obtained during London fogs are black, and a dense fog gives 40,000 to 50,000 particles per cubic centimetre.

For comparison with June 6, a dust record taken at 7 P.M. on the evening of June 10 at Cheam gave less than 100 dust particles per c.c. The wind was strong and blowing from the west, and visibility very good.

J. S. OWENS.

Perseid Meteors in July 1592.

WITH reference to Dr. Fotheringham's interesting comments in NATURE, June 9, p. 774, on the probable shower of Perseids in 1592, I thought it best to accept the date kindly sent to me by Mr. Beveridge, as it fell near the time when a shower might be expected to occur. However, the shower of 1592 appears to have been 19 days earlier than the correct time, and this (with another reason stated later) at once throws doubts on the identity of the display with the true Perseids.

The near correspondence in epoch may still, however, occasion some suspicion that the Perseid shower formed the incident recorded in history, though the exact date and direction of the meteor flights are incorrectly given. This idea is encouraged by the fact that in two other cases (A.D. 784 and 865) the shower dates differed 10 days from the normal.

It is perhaps important to remark in this connexion that several rich showers of non-Perseids have been frequently observed in modern times which do not differ materially from the date of the Perseids. Three of these may be mentioned as possibly the same as the ancient showers recorded which failed to conform with the exact Perseid dates.

(1) There is a strong shower at $303° - 9°$ near α Capricorni on July 25-August 6.

(2) A rich display from $339° - 11°$ in Aquarius on July 26-August 2.

(3) A fine shower seen in 1879 from Draco $291° + 60°$ on August 21-25.

If the meteors of 1592, to which Mr. Beveridge has directed attention, "traversed the heavens from west to east," as stated in the ancient chronicle, they could scarcely have been Perseids, for the latter are moving nearly from east to west, and this seems an important detail.

The direction of the meteors of 1592 from west to east means that their apparent motions must have been slow and that they were overtaking the earth in its orbit. The Perseids belong to another class; they are swift objects meeting the earth at a velocity of 38 miles per second. I was not aware until I saw Dr. Fotheringham's letter that the direction of the meteors had been described as from west to east.

I adopted a period of 11·75 years (*Observatory*, May 1923) as agreeing with a large number of abundant returns of the Perseids and as it seemed the best to be derived. I directed attention to it in the hope that future observers would bear it in mind and test it in the light of additional observations.

W. F. DENNING.

44 Egerton Road, Bishopston,
Bristol, May 30.

Tactile Vision of Insects and Arachnida.

WITH regard to Father O'Hea's letter in NATURE of May 26, p. 705, I wish to point out—

(1) That I originally questioned the statement that the house-fly and certain spiders avoided the approach of one's hand by detecting "convection currents."

(2) That experiments in this direction can only be made with *totally blind* insects.

(3) That I have not stated that vision is universal or even general among insects and arachnida possessed of eyes, and I offer no explanation (at present) of the use or purpose of "sightless eyes." Neither can I enter a discussion on "vision and light-sensitiveness."

I do maintain, however, that many species form comparatively clear images and can judge distances. The fact that a male Attid (and some Lycosids) will perform for the benefit of a female in an adjacent glass tube is at present only explicable on the assumption of vision. Father O'Hea has not, he says, worked on this point, and I persist in offering it as a preliminary objection to his hypothesis. This discussion cannot, however, proceed to any satisfactory conclusion until we have his further evidence for a large number of species; and until this is forthcoming I should suggest that a generalisation on the question of vision among arthropods cannot be made.

G. H. LOCKET.

Salmon's Cross, Reigate, Surrey.

The Eötvös Torsion Balance and its Use in the Field.

By Capt. H. Shaw and E. Lancaster Jones.

The problem of locating from the surface mineral deposits in the interior of the earth presents numerous difficulties, and has been considered by many investigators who have employed methods based on the physical properties of these bodies, utilising electrical, magnetic, seismic, and density effects. Speaking generally the useful minerals are of either very high or very low density, so that a method dependent upon the difference in density between the mineral and its surroundings would appear to be suitable for the location of such deposits, especially as these effects are noticeable at a considerable distance.

The attraction due to a heavy body is superimposed upon the normal force of gravity at any point in its vicinity, and it is by observations on this local field by means of a torsion balance that the disturbing mass may be located most readily.

The torsion balance of Michell and Cavendish was redesigned and employed for this purpose in 1888 by Baron Roland von Eötvös, professor of physics at Budapest, who gave to the balance a new construction which is retained essentially in the modern instrument, although numerous improvements have since been introduced.

The essential features of the balance can be seen on reference to Fig. 1. A light aluminium beam loaded with platinum weights is suspended by a fine platinum iridium torsion wire. One of the weights is attached directly to one end of the beam, but at the other end the weight is suspended about 60 cm. below the beam by means of a fine wire.

The forces of gravity acting on the two masses are not wholly vertical, but have small horizontal components which give rise to a minute horizontal torque tending to rotate the balance arm. The displacement of the beam relative to its case is observed by means of a telescope and scale fixed to the case, with the aid of a mirror carried by the beam.

When the position of equilibrium of the system has been read, the entire beam and case are rotated through 72° and the observation repeated. Five observations are thus obtained in one revolution of the balance, and the readings in these positions are sufficient to furnish the information required for the station at which the balance is situated.

The modern type of balance consists of two similar beam systems placed side by side, with the suspended weights at opposite ends, and as with this type only three observations at angles of 120° are required for a complete determination, a considerable saving of time results. These improved instruments are in some cases fitted with photographic recording arrangements, the balance case being rotated automatically into its new azimuth after the beam has come to rest and the exposure made.

The suspended system requires most careful protection against convection currents and other disturbing influences, and consequently is enclosed in a double or treble-walled brass case of uniform thickness. Temperature and radiation effects are thus reduced considerably, while the additional precaution is taken of working at night, thereby eliminating solar radiation effects and securing a greater constancy of temperature. Under these conditions the instrument is found to give uniform and satisfactory results in the field when protected only by a tent.

In order to secure the necessary degree of sensitivity it is essential that the period of oscillation should be large, and Eötvös has succeeded in obtaining a period of swing of 1500 to 1800 seconds by employing weights of 30 grams and a beam of 40 cm. length, the lower

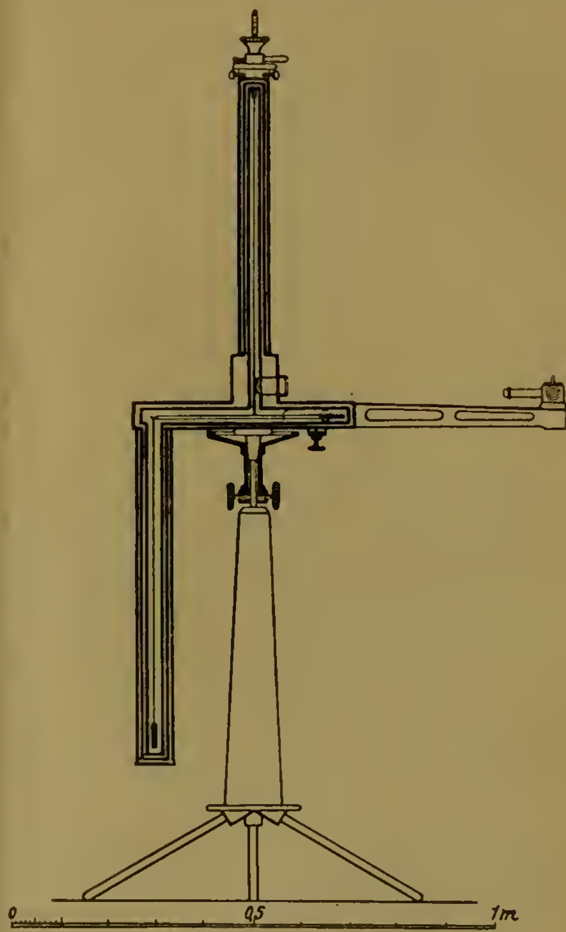

Fig. 1.—Section of balance.

weight being suspended at a depth of about 60 cm. below the beam. The sensitivity of the instrument is partly controlled by the coefficient of torsion of the suspension wire, and by using a platinum wire 0·04 mm. in diameter, alloyed with 20 per cent. iridium, it is possible to measure variations of gravity to within one 10^{-9} C.G.S. unit per centimetre. These wires, which have hitherto proved the most suitable for the purpose, are previously subjected to a special "baking" treatment with the view of eliminating remanent torsion. Similar instruments of smaller dimensions have been constructed and tried by Eötvös, but were subsequently abandoned as being unsatisfactory. Quartz fibres have also been employed in place of the torsion wire, but it was found by Eötvös that a quartz fibre which is sufficiently strong to carry the loaded beam is more rigid than the platinum iridium wire and in consequence a smaller deflexion of the beam results. It was partly owing to this fact and partly owing to the exceptional fragility of the quartz fibre that it was not adopted by Eötvös in his field instrument.

The action of the balance and the nature of the quantities measured may be appreciated from the following consideration. Let a system of rectangular co-ordinates Ox, Oy, Oz, Fig. 2, have its origin O at

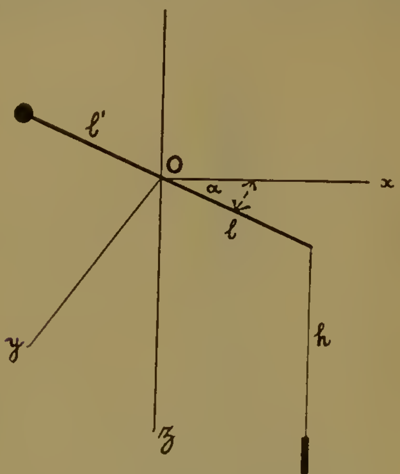

FIG. 2.—Diagram of beam system.

the centre of gravity of the balance beam, the axis Oz directed downwards in the line of resultant gravity at O, and the axes Ox, Oy towards the geographical north and east respectively. It is assumed that a potential function U exists for the gravitational field about O and that, for points not outside the range of swing of the balance beam, we can put

$$U = U_0 + g_0 z + \tfrac{1}{2}U_{11}x^2 + \tfrac{1}{2}U_{22}y^2 + \tfrac{1}{2}U_{33}z^2$$
$$+ U_{12}xy + U_{13}xz + U_{23}yz,$$

where U_0 is the value of U at O,
,, g_0 ,, ,, ,, the resultant force at O,

and U_{11}, U_{12}, etc. depend only on O, not on x, y, and z. Such an assumption is justified whenever gravity is normal, or even if there are irregularities in the field, provided the disturbing masses are fairly distant from the balance.

If the balance beam lies in any position in the plane Oxy, making an angle α with the axis Ox, its main mass is concentrated at two points of which the co-ordinates are $(l' \cos(\alpha+\pi), l' \sin(\alpha+\pi), 0)$ for the upper weight and $(l \cos\alpha, l \sin\alpha, h)$ for the lower. The potential of the whole system will therefore depend on α, and will only be a minimum or maximum for a limited number of values of α. For all other azimuths the beam will tend to rotate so as to set itself in a position of minimum potential, and will actually rotate until this tendency is balanced by the torsion of the suspension wire. The latter, measured by means of the telescope and scale, affords a means of determining the twisting moment due to the gravitational field at any value α, and thus enables us to evaluate the quantities which specify the field and the torque due to it. It is shown in the mathematical theory that these quantities are none other than the magnitudes

$$(U_{22} - U_{11}),\ U_{12},\ U_{13},\ \text{and}\ U_{23},$$

which are thus determined for every station O.

APPLICATION OF THE BALANCE.

The magnitudes $(U_{22} - U_{11})$, U_{12}, U_{23}, U_{13} determined by the balance are not sufficient to enable us to reproduce the complete gravitational field about O—in other words, to describe its equipotential surfaces—since we require to know both U_{11} and U_{22} separately, and also U_{33} and g_0. Eötvös, however, has shown that, by means of the four magnitudes determined by his balance, and one or two pendulum measurements, the magnitude of g, the force of gravity, can be determined throughout a region where the earth's surface deviates only slightly from the equipotential surface through the base point. The balance is thus of great service to geodesy.

In recent years, however, the balance has been extensively employed for work having a wider appeal than the problems of geodesy. By its capacity to explore the regions below the earth's surface, not by penetrating it but by remaining always on the surface, it has proved itself a valuable ally to the geologist, and its use is superseding much of the costly boring and drilling hitherto necessary in locating mineral deposits. Wherever such deposits differ sufficiently in density from their surroundings, and are sufficiently extensive to cause appreciable irregularities in the gravitational field at the surface above them, the balance not only registers their existence, but also helps to determine their density, shape, extent, and depth below the surface, so that, in favourable circumstances, a single boring may suffice to settle any remaining doubts regarding the nature and size of the deposit. In this work of exploring subterranean disturbing masses, the same four quantities $(U_{22}—U_{11})$, U_{12}, U_{23}, and U_{13} are employed, but the influence of all known disturbing masses, and the normal field due to the size and shape of the earth, must be calculated and eliminated before accurate conclusions regarding the unknown masses can be drawn. This may be a very laborious and complicated process, and may even be impossible in unfavourable regions, *e.g.*, where there are mountain ranges of an irregular character in the vicinity.

In such regions, however, the variations of strata as regards character and shape are frequently sufficiently apparent from surface indications to render the use of the instrument unnecessary, so that the balance is of most use where it is most accurate, namely, in regions presenting a regular and comparatively unbroken surface, but having important irregularities below the surface.

In this work, certain simple combinations of $(U_{22} - U_{11})$, U_{12}, U_{23}, U_{13}, are more useful than the magnitudes themselves. Those mainly used are S, R, λ, μ, where

$$S = \sqrt{U_{13}^2 + U_{23}^2}, \qquad R = -\frac{1}{g}(U_{22} - U_{11}) \sec 2\lambda,$$

$$\tan\mu = \frac{U_{23}}{U_{13}}, \qquad \tan 2\lambda = -\frac{2U_{12}}{U_{22} - U_{11}}.$$

The magnitude S represents the "maximum gradient of gravity in the horizontal surface," *i.e.*, the maximum amount by which the vertical force of gravity is increased as we proceed from the origin through unit distance in any direction in the horizontal surface, and is obviously the resultant of U_{13} and U_{23}, the gradients in the direction Ox, Oy respectively. Also the direction of this maximum gradient is given by μ, the angle which it makes with Ox.

The magnitude R is equal to the difference between the reciprocals of the principal radii of curvature of the level surface at O, and is always positive. Thus, if ρ_1 is the least radius of curvature at O, and ρ_2 the greatest,

$$R = \frac{1}{\rho_1} - \frac{1}{\rho_2},$$

while λ is the angle which the plane of greatest radius of curvature, or least curvature, makes with the plane Oxz.

The work of survey consists in finding these values S, R, λ, μ at as many stations as possible, correcting them for normal gravity effects and known irregularities, and plotting the final values, representing the maximum gradient S by an arrow drawn through the station in the direction μ, and proportional in length to the magnitude of S, and indicating R by another arrow in the direction λ. The positions, directions, and lengths of these arrows are then compared with the corresponding arrows given by certain simple mass distributions of which the effects can be calculated, and the probable distribution corresponding to the observed results is deduced.

To illustrate the gravitational effect of a subterranean mass and the variation of the magnitudes measured by the balance from point to point on the earth's surface above such a deposit, we may consider the simple case represented in Fig. 3. Here a horizontal layer of matter, having a density greater by unity than its surroundings, is bounded on the top and bottom by horizontal surfaces at depths 200 and 300 metres below the earth's surface. The layer extends to infinity in the north, east, and west directions, but terminates at the south end in a vertical plane through the east-west line. Let O be a point on the earth's surface on the line where this vertical boundary meets the latter, x'Ox the meridian through O, and Oz the downwards vertical meeting the faces of the deposit in A and B. Consider the force of gravity due to the deposit alone—which is thus to be regarded as having a density unity—at any point X on x'Ox. The force at X will be wholly in the plane xOz, and the corresponding potential surface through X will be a cylinder having its axis perpendicular to this plane. In these circumstances the magnitudes U_{11}, U_{12}, etc., specifying

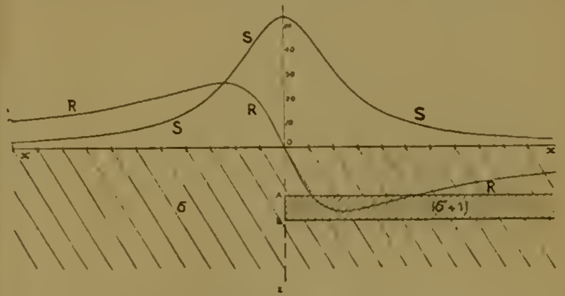

FIG. 3.—Results for a simple case.

the disturbing field due to the deposit, can easily be calculated. Moreover we have

$$U_{12} = U_{22} = U_{23} = 0,$$

and therefore

$$\lambda = \mu = 0 \text{ or } \pi,$$
$$R = U_{11},$$
$$S = U_{13}.$$

In Fig. 3 the values of U_{11} are plotted as ordinates corresponding to the abscissæ OX in the curve RRR, and the values of U_{13} in the curve SSS. It will be noticed that the point O, vertically above the edge of the deposit, is strongly marked in each curve by a maximum on one and a zero value on the other. The maximum value of S has a magnitude 53×10^{-9} C.G.S. units, and the maximum of R is 26×10^{-9} units. Since values of R and S as low as 1×10^{-9} unit affect the balance, it is apparent that the instrument would readily show the effects due to such a subterranean deposit, and indicate its extremity.

Science and Industry in Sweden.

THE exhibition recently opened at Gothenburg to celebrate the tercentenary of the founding of that city by Gustavus Adolphus, with its display of Swedish manufactures, is an eloquent reminder of the part taken by Sweden in the development of certain industries and also of the debt of the world to Swedish men of science. Though she cannot lay claim to mathematicians of the rank of Leibnitz, Newton, or Euler, or to astronomers equal to Galileo or Herschel, in chemistry and mineralogy Sweden has often led the way, and few countries can boast of names more widely known than those of Bergmann, Scheele, Gadolin, Berzelius, Nilson, Cleve, and Arrhenius.

The rise of science in Sweden is generally traced to Linnæus, but it really had its foundation in the middle of the seventeenth century. Like all the western nations Sweden felt the influence of the discoveries of Copernicus, Kepler, and Galileo, and one of the objects the young and eccentric Queen Christina had in view when she invited Descartes to her capital, was to place him at the head of the academy she proposed to establish. The plans of Christina, however, came to nothing, for Descartes died in 1650 and four years later she herself abdicated.

Sweden has a comparatively large territory but a very limited population. Until recent times there were but two seats of learning, Uppsala and Lund. Both are still small cities, the former having about 20,000 inhabitants, the latter some 4000 less. Uppsala is about 40 miles north of Stockholm, while Lund is not far from Malmö in the extreme south. Lund University was founded in 1666, Uppsala in 1476. It was in Uppsala that Swedish science had its birth, and there it has found its principal home. Johann Gestrin and Magnus Celsius (1621–1679) were among the mathematicians of Uppsala during the seventeenth century, the former being the author of a commentary on Euclid and works on astronomy and mechanics. The grandson of the latter, Magnus Celsius, was Anders Celsius (1701–1744) who accompanied Clairaut and Maupertuis on their degree-measuring expedition to Lapland. To him we are indebted for the Centigrade thermometer. For some years he was professor of astronomy at Uppsala.

The great Swedenborg (1688–1772), the learned Klingenstierna (1698–1785), Martin Stroemer (1707–1770), Peter Elvius (1710–1749), and Peter Wargentin (1717–1783) were all either students or professors at Uppsala, as was Melanderhjelm (1726–1810), whom Brougham met when he attended a meeting of the Royal Academy of Sciences at Stockholm in 1799. Klingenstierna was the discoverer of the fact that refraction of light could be produced without colour; Stroemer made the first Swedish translation of Euclid, while Wargentin devoted much of his life to a study of Jupiter's satellites and was associated with Lacaille in his work on the parallax of the moon. He was also the first director of the observatory at Stockholm founded in 1759 largely through the instrumentality of the capable and public-spirited administrator, Claude Grill (1704–1767).

Of all the men of science connected with Uppsala the place of honour must be given to Linnæus, whose tomb is in the Cathedral there. Whether we think of him as a boy watching the bees and flowers in his father's beautiful garden at Rashult, as the budding botanist at the school at Wexio, or as the struggling student first at Lund and then at Uppsala, or again as the intrepid explorer in the wilds of Lapland, we are impressed with his untiring energy and his singleness of purpose. Born in 1707, at the age of twenty-three Linnæus became an assistant professor at Uppsala, but the years 1735 to 1738 he spent in travel. In Holland he became the friend of Boerhaave and worked in the garden of the wealthy Clifford, near Haarlem. He also visited England, France, and Germany, and it was during this time he brought out the first edition of his "Systema Natura." Returning to Sweden he was made the president of the newly founded Academy of Sciences at Stockholm, and in 1741 became professor of anatomy at Uppsala, where he died on January 10, 1778. With his never-ceasing industry he combined a passionate love of order, and it has been said that thus "he was able to serve his own generation with great effect, to methodise the labour of naturalists, to devise useful expedients for lightening their toil, and to apply scientific knowledge to the practical purposes of life."

Contemporary with Linnæus, but occupied with a different branch of science, was Johann Wallerius (1709–1785), the writer of many scientific books and for a long time professor of chemistry, metallurgy, and pharmacy. It was to his chair that Bergmann succeeded in 1767. A native of West Gothland, where he was born in 1735, Bergmann as a student came under the influence of Linnæus and passed nearly the whole of his life at Uppsala. He was one of the earliest chemists to deal with chemical problems in a strictly scientific manner, and he was the pioneer of systematic chemical analysis. Holding his chair until his death in 1784, he counted among his pupils Johann Gahn (1745–1818), who added manganese to the list of elements and instructed Berzelius in the use of the blowpipe, and Johann Gadolin (1760–1852). Gadolin became a professor at the university of Abo, then belonging to Sweden, and to him Finland was indebted for the introduction of a knowledge of the discoveries of Lavoisier and the other French chemists. The town and university of Abo were destroyed by fire in 1827, but when visited by Bishop Heber, the writer of the hymn "From Greenland's icy mountains," in 1805, he described it as "a place possessing an archbishop, fifteen professors, three hundred students, a ruined castle, a whitewashed cathedral, and certainly the most northerly university in Europe."

Gadolin had been a candidate for the chair left vacant by the death of Bergmann, but this was given to Afzelius (1755–1837). Bergmann's greatest contemporary was undoubtedly Scheele. Seven years younger than Bergmann, Scheele began life as an apprentice in Gothenburg. From Gothenburg he removed to Malmö, then to Stockholm and to Uppsala, and finally settled at Koping where he purchased a business. It was here he made his great discovery of oxygen. Endowed with a genius for resolving the most obscure chemical reactions, Scheele stands almost unrivalled for the number and value of his discoveries. He died two years after Bergmann, and his statue now adorns the Swedish capital.

Though, with the death of Bergmann and of Scheele, the progress of chemical discovery slackened somewhat, the greatest of Swedish chemists had yet to appear. Berzelius, who stands beside Linnæus in the roll of Swedish science, was born in 1779, a year after Davy. In 1798—the year Davy went as assistant to Beddoes at Clifton—Berzelius became an assistant to the medical superintendent at Medvi. While Davy was establishing his reputation at the Royal Institution, Berzelius as a professor of medicine was gaining the admiration of Stockholm, and on Davy's death in 1829 he was recognised as the leading chemist in the world. Sir William Ramsay once remarked that he believed that since the time of Boyle none had done more for the advancement of chemistry than had Berzelius. His kitchen laboratory at Stockholm was as famous as that of Lord Kelvin in the cellar beneath the old College of Glasgow. Dulong, Mitscherlich, Gmelin, Gustav and Heinrich Rose were all taught there by the great master, and Wöhler has fortunately left a description of it. "The laboratory," he said, "consisted of two ordinary rooms furnished in the simplest possible manner; there were no furnaces or draught places, neither gas nor water supply. In one of these rooms were two common deal tables; at one of these Berzelius worked, the other was intended for me. On the walls were a few cupboards for reagents; in the middle was a mercury trough, while the glass blower's lamp stood on the hearth. In addition was a sink, where the despotic Anna, the cook, had daily to clean the apparatus." When in 1833 Berzelius married, the King of Sweden wrote of him, "Sweden and the whole world were debtors to the man whose entire life had been devoted to pursuits as useful to all as they were glorious to his native country."

Berzelius died in 1848, and the torch of chemistry has been handed on by worthy successors such as Lars Fredrik Nilson (1840–1899) and Per Theodor Cleve (1840–1905), while to-day science in Sweden has no more illustrious name than that of Svante Arrhenius, the originater of the theory of electrolytic dissociation and the director of the Nobel Institute of Physics, who began his career in the old university where Bergmann had taught.

While chemistry in particular has flourished in Sweden, other sciences have by no means been neglected. In all that appertains to the sea and fisheries, to agriculture and forestry, and to exploration, much valuable work has been done. One of the meetings to be held at Gothenburg this summer is the Congress of Scandinavian Naturalists. In astronomy, in physics, and in geology, Sweden has also played her part. Uppsala has possessed an observatory since about 1730, and during the nineteenth century this was directed by Gustav Svanberg (1801–1882), Herman Schultz (1823–1890), known for his micrometrical measurements of nebulæ, and by Nils Christophr Duner (1839–1914), who devoted himself to a study of stellar spectra and in 1892 received the Rumford Medal of the Royal Society. Another well-known astronomer was Hugo Gylden (1841–1896), for more than twenty years head of the Stockholm observatory, where Backlund was his pupil. Anders Jonas Ångström (1814–1874) began his career in the Swedish observatories, but his great work on the solar spectrum was done while he held the chair of physics at Uppsala to which he was appointed after the death of Adolph Svanberg (1806–1857). Ångström's successors, Tobias Thalen (1827–1905) and Knut Johan Ångström (1857–1910), were also distinguished workers in spectroscopy, while it was said that Thalen's magnetometer was in use in every iron mine of importance in Sweden.

Geological studies in Sweden may be said to have been begun with the writings of Urban Hiarne (1641–1724), physician to the king, who in 1694 published his views on the history of the earth. Some of the earliest geological maps of Sweden were prepared by Gustav Hermelin (1744–1820) a student of Uppsala and an officer in the Swedish mining service. Geological surveys of Norway and Sweden were inaugurated in 1858. Among the directors have been Otto Torell (1828–1900) and Alfred Törnebohm (1838–1911). In a country possessing rich mineral deposits, the work of these geologists has been of the greatest value.

Apart from agriculture, which still employs about half the population of 6,000,000, the main industries of Sweden depend on the iron mines, the magnificent forests, and the ample water power. The manufacture of wood pulp and the timber trade have grown enormously. At one time Sweden was the principal iron-producing country in the world. Though to-day her position in this respect is much more modest, the quality of her iron is still unrivalled. The steam engine was introduced into Sweden by the Swedish man of letters, Abraham Edelcrantz (1754–1821), while the first marine engine was made by Samuel Owen, whose bust has been placed in the Gothenburg Exhibition together with a model of the engine he built. In the field of shipbuilding Sweden has done much pioneering work, and at one time no writings on naval architecture were more highly esteemed in England than those of Chapman (1721–1808), who was a native of Gothenburg. The famous engineer and naval architect, John Ericsson, was a Swede, and began work on the Göta Canal, which had been first surveyed by Swedenborg, but was built to the plans of the British engineer Telford. Ericsson was in England from 1826 to 1839; he then emigrated to the United States and it was there that he produced the *Monitor* which during the civil war saved the North. After his death in 1889, Ericsson's body was sent to Sweden in an American warship, and it now lies at Filipstad in the beautiful Wermland district.

Many Swedish civil and mechanical engineers have gained a world wide-reputation. Nordenfelt, who died in 1920, was one of the pioneers of the submarine, Goransson, who died in 1900, assisted in perfecting Bessemer's great invention, while Fredrik Kjellin (1872–1910) was a pioneer of the electric steel industry. Of the three brothers Nobel, it was Alfred Bernhard Nobel (1833–1896) who first produced dynamite and afterwards left more than a million sterling to found the Nobel prizes. The list could be lengthened considerably, but few names have stood higher than that of Gustav de Laval (1845–1913), whose cream separators are to be found in use all over the world; he is also widely known as the inventor of the de Laval steam turbine, the first patent for which was taken out in 1884, the same year that the Parsons turbine was patented. De Laval, it may be added, was a student and graduate of Uppsala University, and was thus one of the makers of modern Sweden who laid the foundation of their knowledge in the ancient university where Swedish science had its birth.

Current Topics and Events.

An important paper by Prof. Georges Dreyer, of Oxford, in the last number of the *British Journal of Experimental Pathology* has been the subject of widespread comment, as, apparently, it is likely to inaugurate a new era in the specific treatment of infective disease, and particularly of tuberculosis. It is a matter of common knowledge that the "tuberculins" hitherto employed have not been completely successful against the highly resistant bacillus of tuberculosis. Dreyer's main thesis—and it is supported by a mass of accurate experimental evidence—is that the relative failure of certain vaccine preparations is due to the presence in some bacteria of various lipoidal substances which, covering or incorporated with the protoplasm of the microbe, offer a considerable protection to the latter, so that it is able to escape the destructive bactericidal and other antibodies which are evoked by the host in response to the infection. By a process consisting essentially of the extraction of the lipoids, the "defatted" bacteria have been found not only to preserve their antigenic properties, but also the latter are actually enhanced when compared side by side with antigens which still preserve their lipoids. The bulk of Dreyer's work refers to tubercle bacillus, and there can be no doubt that, so far as this microbe is concerned, he has proved his point experimentally. From his protocols he appears to have done what has not been done before, namely, the arrest, clinical and histological, of tubercle in guinea-pigs. It has always been felt that any method which could bring this about offered great hopes in the treatment of tuberculosis. It is necessary, however, at this stage to adopt an attitude of caution as regards the treatment of human pulmonary tuberculosis, for it will be a long time, probably years, before the full value of the method can be assessed.

In the issue of *Science* for May 18 prominence is given to a communication entitled "Problems in the Field of Animal Nutrition," issued by the sub-committee on Animal Nutrition of the United States National Research Council. The paper is an endeavour to indicate problems and fields of research worthy of study in relation to animal nutrition. It is noteworthy that under this heading are included such diverse subjects as human dietetics, animal and forage husbandry, judging and food requirements of farm animals, and diet in relation to reproduction. There are undoubtedly great advantages in describing and defining the objects of scientific research, but it is, perhaps, permissible to stress the fact that, in the last resort, the organisation of research depends upon the supply, and, what in this connexion may be termed, the "nutrition," of qualified scientific workers! So far as Great Britain is concerned, it would appear that the majority of the problems indicated (with the exception, perhaps, of the scientific judging of farm animals) are the subject of study in one quarter or another. For example, at Cambridge great additions to the knowledge of nutrition continue to be made at the School of Bio-chemistry under Prof. Gowland Hopkins, and at the School of Agriculture, under Prof. T. B. Wood, workers on nutritional calorimetry and the physiology of reproduction continue to make progress. The most prominent consideration, however, before workers on the scientific aspects of nutrition in Great Britain is the need for the careful study of what may be termed the balance of essential food substances, as distinct from the absolute amounts of each of such, and it would appear that a great deal has still to be learned as to the interplay in nutrition between the relative quantity of proteins, carbohydrates, minerals, and even vitamins, which may be contained in diets, both in health and disease. On the applied side of the subject, the ultimate (and most difficult) problem is, undoubtedly, how effectively to introduce science into a subject so much at the mercy of fashion and prejudice as the feeding of animals.

A paper by G. McCready Price on "The Fossils as Age-markers in Geology" (*Princeton Theological Review*, vol. 20, p. 585, 1922) affords interesting evidence, even in its place of origin, of the campaign that is being carried on in the United States against the recognition of organic evolution. The author states that he is a geologist, who has convinced himself that no true sequence of faunas is traceable in the rocks, and that zoological provinces may have existed in which trilobites, nummulites, and ammonites lived simultaneously in various portions of the globe. The apparent absence of eroded surfaces between stratified series that are judged, by their fossil contents, to differ widely in their age is regarded as a proof that no gap in the sequence has occurred. On this matter the author should study L. F. Noble's paper on the succession in the Grand Cañon of Arizona, which was recently noticed in Nature (April 7, p. 480). It is alleged that thrust-planes and reversals by folding have been called in as explanations by those who still cling to the views put forward by William Smith. It may be noted that the pioneers in the establishment of faunal sequences had no concern with doctrines of evolution; but Mr. Price states that those geologists who are "acquainted with scientific methods" have recently changed their views and accept a "new geology." When we find that the new geology accounts for an imaginary mingling of strata by the occurrence of a universal deluge, we realise that its scientific outlook is not younger than that of the Chaldees.

The Albert Medal of the Royal Society of Arts, which was instituted in 1862 as a memorial of the Prince Consort, and is given annually for "distinguished merit in promoting Arts, Manufactures, or Commerce," has been awarded this year in duplicate by the council, with the approval of the president, H.R.H. the Duke of Connaught, to Sir David Bruce and Sir Ronald Ross, in recognition of the eminent services they have rendered to the economic development of the world by their achievements in biological research and the study of tropical diseases.

At a meeting held recently at the Mansion House, a committee was formed with the object of providing a national memorial to the late Sir Ernest Shackleton. The aim is to establish some suitable memorial of a permanent nature, but the first object of the committee will be to provide for the education of Sir E. Shackleton's children and to take his place in supporting his mother. The balance that remains, after meeting these two obligations, will be devoted to the encouragement of exploration. The hon. treasurer of the memorial fund is Mr. Howard Button, 61/62 Lincoln's Inn Fields, London, W.C.2. Subscriptions may be sent to him or to any branch of the National Provincial and Union Bank of England.

In order to commemorate the late Dr. W. S. Bruce, the polar explorer, a Bruce Memorial prize has been founded by subscription among his friends and admirers. The prize, which will take the form of a bronze medal and money award, is to be given from time to time for notable contributions to natural science in the nature of new knowledge resulting from personal visits to polar regions. The prize will be open to workers of all nationalities, with a preference for young men at the outset of their careers as investigators. Arrangements are being made to leave the selection of the recipients of the prize to a representative committee in Edinburgh. Further subscriptions will still be welcomed by the hon. treasurer, Mr. A. N. G. Aitken, 37 Queen Street, Edinburgh.

THE resignation is announced of Sir George Beilby after nearly seven years' voluntary service as director of fuel research and chairman of the Fuel Research Board under the Department of Scientific and Industrial Research, which was established in 1917 to investigate the nature, preparation, and utilisation of fuel of all kinds. Dr. C. H. Lander has been appointed director of fuel research, and Sir Richard Threlfall, a present member of the Board, to be chairman. The Hon. Sir Charles Parsons will continue as a member of the Board for a further period. Sir George Beilby retains his membership of the Advisory Council of the Department, and has consented to act as honorary adviser to the Board. The following have been appointed additional members of the Board: Mr. R. A. Burrows, Sir John Cadman, Dr. Charles Carpenter, Mr. Samuel Tagg, Sir James Walker, and Prof. R. V. Wheeler.

IN his recent presidential address to the Institute of Physics, Sir J. J. Thomson gave some account of the work he saw during his recent visit to America in the research departments of some of the great manufacturing firms. These laboratories were established in the face of considerable opposition, but now the unanimous opinion appears to be that the research department is one of the most profitable in manufacturing concerns, and, however great the necessity for economy, its cost would be the last to be reduced. The scale of the laboratories is far greater than anything in Great Britain, and much of the work carried out is not merely what may be called development work, but is fundamental scientific work, worthy of a university laboratory. On the other hand, the American universities do not seem designed to produce a large number of men qualified to take up advanced research work. For example, few of the science students have the necessary equipment in mathematics, and the stern training which a good honours man in a great English university has to go through appears to be unknown. The system is doubtless good for the average man, but a successful research institute requires something more than the average man: it needs men with high scientific knowledge. In this regard, Great Britain has a distinct advantage which is sorely needed if it is to hold its own in competition.

THE annual conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, Cromwell Road, S.W., on Thursday, June 28, at 8.30 P.M.

IT is announced in the *Times* that Sir E. Wallis Budge, keeper of Egyptian and Assyrian antiquities at the British Museum, has been elected a foreign correspondent associate of the Lisbon Academy of Sciences.

A REPLICA of the portrait of Benjamin Harrison, painted a short time before his death by Mr. Cyril Chitty of Ightham, has been purchased by private subscription and presented to the Maidstone Museum. It has been placed in the room in which selected examples of Mr. Harrison's flint implements are exhibited.

THE annual general meeting of the Institution of Gas Engineers is to be held on June 26-28 in the City Hall, Belfast. At the first session of the meeting the Birmingham medal will be presented to Mr. W. Doig Gibb, and Mr. J. D. Smith, engineer and manager of the Corporation Gas Works, Belfast, will deliver his presidential address. A number of reports and papers will be presented to the meeting and discussed.

"NATIONAL Baby Week" will be observed on July 1-7, and we have received from the National Baby Week Council (117 Piccadilly, W.1) pamphlets explaining the object of baby week and how to organise a baby week celebration, and dealing with the activities of the Council. The Council desires to promote in the widest sense the safeguarding of infant life.

IT is stated in the *British Medical Journal* that Dr. Kleiweg de Zwaar, of Amsterdam, has instituted a triennial prize of the value of 2500 francs, which will be awarded for the first time in 1924 for the best work in physical or prehistoric anthropology during the preceding three years. Candidates should apply before November 1 to the Secretary, École d'Anthropologie, 15 rue de l'École de Médecine, Paris.

THE Society of Glass Technology has issued a provisional programme for its visit to France on June 30-July 6. The details of the meeting are being arranged by M. Delloye, of the Glaceries de St. Gobain, Chauny, and Cirey, and visits to a number of glass factories in and near Paris are promised. On July 2 there will be a joint meeting for the presentation and discussion of papers with the French Society of Civil Engineers, and it is hoped that Prof. H. le Chatelier will address the meeting.

THE centenary of the death of the famous horologist, Abraham Louis Bréguet, will be celebrated in Paris on October 22-27, by an exhibition of his works at the Musée Galliera, a special meeting at the Sorbonne, and a reception at the Hôtel de Ville. The Congrès National de Chronométrie will also meet in Paris in October, under the honorary presidency of M. Baillaud, director of the Paris Observatory, and of General Sebert. Besides discussing general questions relating to chronometry, the congress will aim at the formation of a Chronometric Union under the direction of the International Research Council.

THROUGH the great generosity of Mr. Charles Heape, of Rochdale, the Manchester Museum will shortly come into possession of a fine collection of native implements, ornaments, and weapons, which will add greatly to the value of the ethnological collection that it already possesses. The bulk of the specimens are drawn from the Pacific, but the collection also contains some objects from the Eskimo and from Egypt. The collection has been catalogued by Messrs. Heape and Edge-Partington, and the catalogue was printed some time ago, and issued privately. It would be of great advantage to ethnology if, some day, this invaluable source of information should be reissued, if necessary by subscription. The collection contains a representative set of Polynesian weapons. There are also many examples of shell-work, especially of mother-of-pearl, which should be of great interest, and much that will be of considerable use to the student of ornament. When the exhibits are classified and exhibited they will form an excellent foundation for the study of the material culture of Occania.

AT a recent meeting of the council of the Royal Agricultural Society, some account was given of the work in hand by the Society's Research Committee. Experiments are in progress in Leicestershire to test the value of basic slags and other fertilisers as measured by the increase in weight of cattle and sheep. Silage is to be made in clamps or pits at Cambridge and tower ensilage in East Suffolk, and the products are to be used next winter as feed for dairy cows; the effects of the silage on the yield and quality of the milk will be watched. Pig-feeding is also being investigated at Cambridge, where experiments will be made on the effects of grinding, soaking, and cooking on the nutritive value of maize, and on feeding with barley and potatoes, while similar trials will be made at the Harper-Adams Agricultural College on the value of home-grown products; in each case, the weight of flesh produced as well as its quality, will be investigated. The Research Committee of the Royal Agricultural Society is doing valuable work in thus supplementing the investigations carried out at research institutes and aiding in bridging the gap between the research worker and the practical farmer.

THE Société Française de Physique celebrates this year the fiftieth anniversary of its foundation, and to mark the event the Société is organising a National Physical and Wireless Exhibition which will be held in the Grand Palais, Paris, on November 30–December 17, concurrently with the Aeronautical Exhibition. The list of patrons, headed by the president of the Republic and the chiefs of the various ministries, includes leading personalities of the French scientific and industrial world. A guarantee fund of one million francs has been subscribed by eighty-two firms and individuals. The exhibition, which will embrace the principal scientific and industrial applications of physics, is to be divided into the following sections: Experimental physics; retrospective display of physical apparatus; radio-telegraphy and telephony; vacuum, X-ray and thermionic tubes; biological physics, physiology; telegraphy, telephony, signalling; various industrial and domestic applications of electricity; electro-chemistry; electric cables; glass, porcelain and other insulating materials; optics; photography, cinematography; illumination; rarefied and compressed gases; heating; metallurgy; acoustics; measuring and control apparatus; and instruction, books, reviews.

THE forthcoming meeting in London of the International Association of Navigation Congresses is an event of outstanding importance in shipping and port circles. The Congress will be held on July 2–July 6, and will be attended by numerous and influential delegates from all over the world, many of whom are contributing reports on matters of which they have expert knowledge. It is the thirteenth meeting of the Association; normally a congress is held every third year, but the regular sequence was broken by the War. The last meeting was at Philadelphia in 1912; consequently much interest and importance attaches to the revival of the gatherings after a lapse of more than ten years. The King has graciously accepted the position of patron; Lord Desborough is president, and there is a strong and influential British organisation committee. The subjects to be discussed include the following: (*a*) Inland navigation: the utilisation of waterways for the production of power and its consequences and applications; the influence of surface waters and subterranean sheets of water on the flow of rivers; and estimation of the water consumed for navigation and irrigation purposes, and the portion returned to the subterranean sheet of water. (*b*) Ocean navigation: the accommodation to be provided for ships in order to satisfy the future dimensions of vessels; mechanical equipment of ports; concrete and reinforced concrete: their applications to hydraulic works; means to assure their preservation and their water-tightness; the use of liquid fuel for navigation and its consequences; the utilisation of tides for the production of power for the working and lighting of ports; and the principal advances made recently in lighting, beaconing, and signalling of coasts, and standardisation (unification) of the languages of maritime signals.

THE Museums Association will meet at the Guildhall, Hull, on July 9-13. On Tuesday morning, July 10, there will be an official welcome by the Lord Mayor, and the president, Mr. T. Sheppard, will give an address on "The Place of the Small Museum." Later, at the Hull Luncheon Club, the delegates will be entertained, and the president will give an address on "The Evolution of a Yorkshireman." A number of papers will be read upon various aspects of museum work, and there will be numerous social functions and visits to places of interest. On Friday morning, July 13, there will be an address on "American Museums" by a delegate from the American Museum of Natural History, New York, and also cinematograph exhibitions. In the afternoon one section will visit York and will be entertained by the Yorkshire Philosophical Society in the grounds there; another party will sail for Copenhagen on the s.s. *Spero*, and from a preliminary programme received from Dr. C. M. C. Mackeprang, of the National Museum at Copenhagen, it appears that the members will be received on Monday morning, July 16, at the National Museum and inspect the National Collections; they will be then entertained to lunch in the Museum. In the afternoon they will visit Rosenborg Castle and later will attend a reception at the Town Hall. On

Tuesday, visits will be paid to Thorvaldsen's Museum and the Museum of Applied Art. In the afternoon the National Art Gallery and the Zoological Museum will be visited, and later there will be a trip in the Danish Expeditionary ship *Dana*, which is under the charge of Dr. Petersen. On Wednesday, July 18, there will be a visit to the Open-Air Museum at Lyngby, a visit to the Natural History Museum in Frederiksborg Castle, where the members will be entertained to lunch, and later a visit to the famous castle at Elsinore. On the following day the members will visit the Glyptotheke, returning to Hull by the s.s. *Spero* on the same evening.

Mr. I. H. N. Evans, of the Federated Malay States Museums, Taiping, has written, for appearance with the Cambridge University Press, "Studies in Religion, Folk-lore, and Custom in British North Borneo and the Malay Peninsula," giving the results of research carried out in the years 1910–21. The same house will publish in the summer "The Banyankole," by the Rev. J. Roscoe. It will form the second part of the report of the Mackie Ethnological Expedition to Central Africa.

In the chairman's report of the National Illumination Committee for 1922, now issued in pamphlet form, it is stated that the provisional definitions of photometric terms and units have now been adopted, and form the basis of a series to be issued shortly by the British Engineering Standards Association. The latter body has been invited to form a sectional committee on illumination. Reference is also made to the committee which is investigating the subject of motor-headlights, and, as a preliminary to suggestions, is considering the recommendations already made in other countries. The pamphlet contains an official translation of the French text of the photometric definitions.

Our Astronomical Column.

Announcement of a New Comet.—Mr W. N. Abbot, the British schoolboy in Athens who recently announced the brightening of Beta Ceti, now reports the discovery of a comet on June 12. The Right Ascension is given as $15^h\ 13^m\ 4^s$, and the Declination 53° 26′ N., in the constellation Draco. As the telegram is not quite in the regular form, there is some doubt whether the Declination may not be the complement of the above, that is, 36° 34′. No further information is at present to hand.

Proposed Solar Observatory in Australia.—This observatory has now been planned for several years; a message, dated April 17, from Melbourne to the *Times* indicates that the arrangements are making considerable progress. The site has been chosen at Mount Stromlo, near Canberra, the federal capital.

Prof. Duffield, of University College, Reading, was then in Australia and was being consulted, together with the Astronomer Royal and Prof. Turner, on the question of the selection of a director. It was proposed that the new director, when selected, should be given an opportunity of visiting, among other observatories, the solar observatory on Mount Wilson. As that observatory takes the leading place in researches on solar physics, it is obvious that the director of the new observatory should be intimately acquainted with its methods, and should arrange a programme of work that would supplement the results obtained there. As the two observatories are some 90° apart in longitude, the Australian station could continue the record of interesting outbursts after sunset in California.

Photometric Observations of the Planet Mercury.—It is of considerable importance to measure the brightness of this elusive little planet, since the result has a considerable bearing on the estimate we form of the condition of its surface. The conditions for doing so are much easier in the tropics, owing to the shorter twilight, the prevalence of clearer skies, and the greater altitude of the planet. Mr. J. Hopmann, who visited Christmas Island for the recent eclipse, utilised the occasion to compare Mercury with neighbouring stars (Arcturus, Spica, Procyon, Regulus, Deneb, Denebola, etc.) and the planets Saturn and Jupiter. On September 5 it was brighter than Saturn by a whole magnitude, on November 5 even brighter than Jupiter, which was, however, lower down. It was seen at Malta on November 15 when only 12° from the sun.

Mr. Hopmann has reduced his observations to distance of Mercury from the sun 0·3871, from the earth 1·0, and obtains the formula $-0{\cdot}711$ mag. $+0{\cdot}03582$ mag. $(\alpha - 50°)$, α being the phase angle sun-Mercury-earth. The first term was given as $-0{\cdot}998$ mag. by Müller and Jost, their second term being practically the same as his. In other words, he makes the planet a quarter of a magnitude fainter, thus indicating a still lower albedo, and a condition of surface probably approximating to that of the moon (*Astr. Nachr.* 5220).

Photographic Studies of Nebulæ.—Mr. J. C. Duncan contributes his third paper on the studies of the form and structure of nebulæ from photographs made with the 100-inch and 60-inch reflectors and the 10-inch Cooke refractor in the years 1920 to 1922 to the *Astrophysical Journal* (vol. 57, No. 3). The previous papers appeared in volumes 51, p. 4, and 53, p. 392, of the same journal. The present communication is accompanied by eleven excellently reproduced plates. Evidence of the existence of dark nebulosity is found in N.G.C. 1977, M 78, the Trifid nebula, the dark objects Barnard 72, 92, 93, and 133, and the American nebula. Of great interest is N.G.C. 4038-4039, a bright spiral of unique form with faint extensions of extraordinary appearance. In a field the size of the full moon in Coma Berenices, the 100-inch telescope photographs no less than 319 small nebulæ. The object N.G.C. 6822 is found to be a mixture of stars and small nebulæ resembling the magellanic clouds.

In examining these reproductions taken with the great 100-inch mirror, one cannot but recall and admire the fine photographs which Dr. Isaac Roberts took with his small mirror of only 20-inches aperture. To take a case in point, it is interesting to compare the reproduction of the nebula N.G.C. 1977 in Orion taken with the 100-inch mirror with Roberts's reproduction in plate 17 in his volume of "Photographs of stars, star-clusters and nebulæ," taken in 1889 and published in 1893. The exposure for Roberts's photograph was 3 hours 25 minutes, while that with the 100-inch was 5 hours 40 minutes. There is very little difference between these photographs except the sharpness of the details and the greater contrast in light and shade, which in the 100-inch reproduction has been secured purposely by repeated copying.

Research Items.

Ethnology of Malta and Gozo.—In the Journal of the Royal Anthropological Institute (vol. lii., 1922) Mr. L. H. Dudley Buxton publishes an exhaustive essay on the ethnology of Malta and Gozo. The skulls discovered in the course of excavation and examination of the existing population lead to some interesting conclusions. The First Race, the Megalith builders, are certainly akin to the early and present inhabitants of North Africa, Sicily, Corsica, Sardinia, and Spain, all belonging to the Mediterranean races. Their successors, the Second Race, exhibit Armenoid characteristics, and were probably immigrants from the eastern Mediterranean. Their arrival probably occurred towards the end of the Bronze or in the Early Iron Age. Armenoids with an admixture of Mediterranean blood, they probably came to Malta from Carthage. They may have destroyed the previous inhabitants, or they may have pursued methods of peaceful penetration. At any rate, they established themselves firmly in Malta, and all later introduction of foreign blood has failed to raise the variation. In later times there have been local variations, but the differences between Malta and Gozo are not greater than the differences between the general population of Malta and at least one, and possibly more, of the more isolated villages.

Treatment of Leprosy.—In a recent lecture delivered to the Royal Society of Arts and published in the Journal of the Society for May 18, p. 452, Sir Leonard Rogers dealt with the problem of leprosy. He estimates that at least three million lepers exist. The disease is communicable, though its infectivity is very slight, and isolation of the infective cases is the only practical preventive measure. Hitherto no effective treatment has been known; but during the last few years, and largely through the researches of Sir Leonard Rogers, certain derivatives of chaulmoogra oil, an old Indian remedy for tuberculosis and leprosy, have been found to exert a beneficial action, and many of the treated cases have lost all signs of the disease and appear to be cured.

Giardias living in Man and other Animals.—*Giardia Lamblia* is a well-known protozoan parasite of the human intestine, and other similar parasites are met with in the intestinal tract of the rabbit, dog, and tadpole. It has been supposed, therefore, that man may become infected from these lower animals. In order to throw some light on this question, the various species have been critically examined by R. W. Hegner (*American Journ. of Hygiene*, vol. ii., No. 4, pp. 435 and 442). *G. duodenalis* from the rabbit and *G. canis* from the dog are considered to exhibit such differences in size, form, and structural details as to constitute species distinct from each other and from *G. Lamblia*. *G. agilis* from the tadpole is more like *G. Lamblia* than the two others, but is sufficiently different to constitute a distinct species. *G. alata*, another giardia from the tadpole described by Kunstler and Gineste, is considered to be identical with *G. agilis*.

Cancer in Plants.—The exhaustive researches of Erwin F. Smith, of Washington, in the pathology of crown gall in plants have led him repeatedly to emphasise the resemblances between the abnormal growths which may be produced in plants by the experimental inoculation of *Bacterium tumefaciens* and malignant tumours in animals. According to his view, which is shared by Jensen, the bacteria provide the stimulus at the beginning of the disease, which is then continued by the stimulated but uninfected cells behaving as parasitic cells similar to cancer cells. A careful re-investigation of the facts by W. Robinson and H. Walkden in Manchester (*Annals of Botany*, vol. cxlvi., 1923, p. 299) does not, however, bear out this interpretation. They find that the careful examination of serial sections usually reveals the relatively close proximity of the causal bacteria to the proliferating tissues, and that there is no evidence that the cells continue to grow in an abnormal way when they are removed from the immediate influence of the bacterium. The analogy with animal cancer, in their view, wholly breaks down.

Fruit-growing in North Carolina.—Supplement No. 19 to the U.S. *Monthly Weather Review* contains a discussion by Mr. Henry J. Cox, meteorologist, on "Thermal Belts and Fruit-growing in North Carolina," and an Appendix by Mr. W. N. Hutt, former State Horticulturist, on "Thermal Belts from the Horticultural View-point." The whole subject is treated with minute detail, specially screened temperature observations having been taken at several fruit orchards and at different positions on the slopes of the same orchard. The subject is well illustrated by plates and diagrams, and the results obtained are scientifically manipulated. Minimum temperature and its duration are the chief factors involved in the growing of fruit. Valley floors must in nearly all cases be avoided unless means are available for orchard heating, since on critical nights of temperature inversion the thermometer at the bottom of valleys often falls 15° or 20° F., and sometimes even 25° or 30° F., lower than higher up on the slope. Dense vegetation is responsible for great loss of heat through radiation, and a cultivated orchard is therefore warmer than one planted in grass. The topography of a region is paramount. The Appendix shows the differences of temperature at 16 stations, and a summary of the horticultural data, such as first bloom, full bloom, and bloom all shed, of apples and peaches, with the cause and date of injury where experienced, and the yield. Much of the damage sustained is due to cold-air traps or frost pockets. In some years a heavy yield of grapes is secured, while apples are a failure, this being due to the later blooming period of grapes. The apple tree is normally an alternate bearer, and the heavy drain on the energies of the trees one year is usually followed by a weaker bud development and lighter crop the following season.

Miocene Cichlid Fish from Haiti.—Prof. T. D. A. Cockerell describes and figures under the name of *Cichlasoma woodringi*, n. sp., an interesting fossil fish from the Miocene of Haiti (Proc. U.S. Nat. Mus., vol. lxiii. art. 7). Cichlid fish abound in South and Central America and in tropical Africa, while fossil representatives have been found in Algeria (Palæochromis) and in the Eocene of Wyoming (Priscacara). Six species or races of Cichlasoma are living to-day in Cuba, and the question arises whether these last are an invasion from the south or the remains of a once widely distributed Antillean fauna. Prof. Cockerell is inclined to hold the latter view.

The Formation of Vitamin-A.—It has been known for some time that the only source of vitamin-A is the plant, and that the green parts are richer in it than the colourless parts are. Dr. Katharine H. Coward has carried the investigation further, and her results are given in two papers in the *Biochemical*

Journal (vol. 17, No. 1, 1923). She shows, first, that light is necessary for the formation of vitamin-A, although neither chlorophyll, carbon dioxide nor oxygen need be present. It can also be formed in the almost complete absence of calcium. A further clue was given by the apparent close association of the lipochrome pigments (carotene, etc.) with vitamin-A in various articles of diet. It had indeed been suggested that the two substances might be identical. But this was disproved by Drummond. The orange-yellow pigment, carotene, is well known as giving the colour to carrots. Dr. Coward found, however, that flowers, or parts of flowers, exposed to light, if they contained carotene, also contained vitamin-A, and that absence of the pigment meant absence of the vitamin. But both may be present in tissues not exposed to light, as in the root of the carrot. Evidence is given that the vitamin has been transported to the root from the leaves. Although the investigator ventures no hypothesis on the matter, it seems highly probable, from the necessity of both light and carotene for the production of vitamin-A, that the pigment acts as an optical sensitiser, similar to chlorophyll for the formation of formaldehyde. It would be of interest to know whether the rays absorbed by carotene are the most effective.

STRUCTURE OF CARBON MONOXIDE AND NITROGEN.—In an interesting paper in the Proceedings of the Physico-Mathematical Society of Japan for April, H. Nagaoka discusses the band spectra of nitrogen and carbon monoxide. He starts with the assumption put forward by Langmuir, that the external electron configurations of the two gases are very similar. The band spectra, which are presumably due to the external electrons of the molecule, should therefore be in close agreement. This is shown to be the case, with small differences indicating slight peculiarities of structure. The author then remarks that the ratio of the specific heats of the two gases cannot be accounted for on the assumption of Langmuir that the two nuclei are in the same cube (a difficulty pointed out by Partington in 1921), and he therefore proposes another model for the gases, in which two cubes are joined at an edge. This would give the correct value of 1·40. The two connecting electrons in the edge are pulled together by the nuclei, so that the resulting external electronic arrangement is that of two tapering six-faced figures connected by a narrow neck. The author points out that the values of the ratio of the specific heats can serve as a useful criterion in differentiating between possible and impossible electron configurations.

PHOTO-ELECTRIC CONDUCTIVITY OF CRYSTALS.—A number of contributions to our knowledge of this subject have been made during the past three years by Drs. B. Gudden and B. Pohl, of the University of Göttingen, in communications to the *Zeitschrift für Physik* and the *Physikalische Zeitschrift*, and a short summary of these is given in the issue of *Die Naturwissenschaften* for May 11. They find that all crystals with high refractive indices possess this conductivity, and that if, when withdrawn from the influence of light, they are insulators, when exposed to it they show an initial conductivity which is relatively large and proportional to the energy of the incident light. When the wave-length of the light is altered, the quotient of the quantity of electricity transmitted divided by the energy of the light incident shows the usual maximum at the wave-length of greatest absorption, but when it is calculated for the energy of the light absorbed, it continues to increase towards the longer waves and eventually becomes a linear function of the wave-length. Over this region the authors consider that the observations justify the conclusion that one quantum of light energy absorbed gives rise to one electron in the crystal.

AMMONIUM SULPHIDES.—Although a solution of ammonium sulphide has been in use in the laboratory for many years, the anhydrous substances are not well known. The solid compounds NH_4HS and $(NH_4)_2S$ were said to have been obtained by Bineau in 1838-39 by the interaction of gaseous ammonia and hydrogen sulphide in the required proportions by volume, but doubt was thrown on the formation of the second compound by experiments of Bloxam in 1895. The matter has been reinvestigated by Thomas and Riding, whose experiments are described in the May issue of the Journal of the Chemical Society. Anhydrous NH_4HS is best prepared by alternately passing ammonia and hydrogen sulphide into dry ether. Attempts to prepare $(NH_4)_2S$ were not very successful. The prolonged action of ammonia on the hydrosulphide in ether produced no sulphide, but on the addition of alcohol a yellow oil separated, which on standing gave some transparent cubic crystals, believed to be $(NH_4)_2S$. The research throws very little light on the formation of the latter substance, but the method of preparation of NH_4HS is a convenient one.

ABSORPTION SPECTRA AND ATOMIC STRUCTURE.—In the *Comptes rendus* of the Paris Academy of Sciences for April 23, M. Victor Henri derives from the study of the absorption spectra of a large number of substances, both in solution and in the state of vapour, some important conclusions bearing on Bohr's theory of atomic structure. He shows that the absorption spectrum of a solution may be either one composed of narrow bands (10-30 Å) disposed in regular series, or one of broad bands (200-500 Å); in a few cases both types of bands are present, but the narrow ones then occur only in the less refrangible regions. When the vapour of the substance is examined, the narrow bands of the solution are replaced by fine lines, while the broad bands of the solution appear also in the vapour as unresolved bands. He explains the narrow bands by the theory of quanta, the molecule being supposed to possess a series of stationary states, of which the energy is determined by the movements of the electrons, atoms, and the molecule. He distinguishes four cases. When the molecule contains only a single double bond, such as C=C, C=O, C=N, N=O, the other atomic groups in the molecule being all saturated, only broad bands are afforded either by the solution or the vapour. When the molecule is as simple as possible, but contains two or more groups with double bonds, narrow bands are given by the solution and fine lines by the vapour, distributed in series conformably to the theory of quanta. When the two double bonds are removed by the introduction of CH_2, the narrow bands run together and form wide bands both in the solution and the vapour. When the molecule is rendered more complex by the substitution of more and more complicated groups of atoms, the narrow bands of the solution enlarge and the fine lines of the vapour fuse together, so that eventually a complicated molecule shows only broad continuous bands. He therefore finally concludes that for molecules containing only one double bond, the first postulate of Bohr is inapplicable, only the second postulate being valid; whereas for molecules with two adjacent double bonds both postulates apply, the first being determined by the existence of an electric polarity in the molecule.

South-Eastern Union of Scientific Societies.

THE twenty-eighth annual congress of the South-Eastern Union of Scientific Societies was held at Maidstone on May 30-June 2 inclusive. Dr. Alex Hill occupied the presidential chair, in succession to Sir Charles F. Close. The headquarters of the Congress were at the Museum, where members were given every convenience by the curator, Mr. J. H. Allchin, and the assistant curator, Mr. H. J. Elgar.

The Mayor opened the meetings by welcoming members and delegates at the Town Hall, where the ancient maces and charters were exhibited and described by Mr. W. H. Day, one of the secretaries, and Mr. W. Dale. Visits followed to various ancient buildings in the town, of which the town possesses a large number. All Saints' Church was visited by more than a hundred members, and was described by Mr. Dale. The church was built in 1395 by Archbishop Courtenay and, although renovated in the last century, remains in practically its original condition, showing in its fine, delicate and lofty columns and its windows the best of the perpendicular characteristics. A very fine set of the original oaken sedilia, with elaborately carved canopies, were seen, and about a score of ancient miserere seats in the choir, which when tipped up have a small seat beneath, giving a sort of rest for tired singers and others. Hard by is the Archbishop's Palace, a stately Elizabethan building, now used as a welfare centre, with wainscoted rooms and old carving. The interesting building known as the tithe barn, with external stone staircase, was also seen. Near at hand and completing the group of ecclesiastical buildings is the massive gateway to the old monks' college, while all were close to the slope leading down to the Medway, much used in early days for travel and transit. The refectory of the Guild of Corpus Christi, in Earl Street, dating from the fourteenth century, was next visited. As a fine piece of mediæval architecture, it deserves a better fate than to be used by a brewery for the making of barrels. It is in dilapidated condition, but the fine roof and the beautiful windows give an idea of its former magnificence. It has a dole window. For nearly three centuries it was occupied by the Grammar School until 1871. Another party of members visited at the same time the bacteriological and chemical laboratories of the Kent County Council, under the guidance of Dr. C. Ponder and Mr. F. W. F. Arnaud.

Dr. Alex Hill's presidential address was on "Antipodean Flora," and in this he gave some interesting facts of the mimicry practised by certain plants observed by him during his journey round the world. Reference was made to the possibility of the isolation of the Australian flora having been accomplished by the dividing-up and the shifting of the land-masses of the Indo-Australian continent in accordance with what has come to be known as Wegener's theory. The means by which eucalyptus and other trees adapt themselves to a rainfall of 8 or 9 inches were described. Exploring the caves at Yallingup, the root of a jarrah tree was met with which had gone down 120 feet in search of water.

The morning session of the second day of the meeting was devoted to botanical papers, and Sir David Prain spoke on "The Story of some Common Garden Plants," the potato, the artichoke, and others being dealt with. A paper by Mr. Robert Paulson on the "Fungus Root" followed. In the afternoon three excursions were arranged. Geologists went to the Aylesford gravel pits and to a Kentish Rag quarry. Botanists followed Dr. A. B. Rendle on an enjoyable ramble, while a large party visited Allington Castle, by permission of Sir Martin Conway. A castle is thought to have occupied the site in Saxon times, and to have been demolished by the Danes prior to their traditional defeat at Aylesford. Owned by Harold Godwin's brother, Ulnoth, it passed into Norman hands and was rebuilt. As it appears to-day, it is for the most part the work of Sir Stephen de Pencester, who fortified it in the reign of Edward I., in about 1281. Tudor additions were made. The famous Sir Thomas Wyatt was once the owner, and as leader of the rebellion to oppose the Spanish marriage of Queen Mary, he suffered the usual fate on its failure. Tennyson lays the first scene of the second act of "Queen Mary" in the court of Allington Castle. In the evening the Mayor and Mayoress (Councillor and Miss Wallis) received the Union in the Museum.

The third day was devoted to papers in connexion with the Regional Survey Section. Mr. Victor F. Branford gave an address on "The Natural and the Social Sciences," a paper which will later be printed in full. A lecture by Mr. F. W. F. Arnaud on "Vitamins" reviewed the history of the discovery of these elusive bodies and showed the present position of our knowledge of the subject. Botanical and archæological excursions followed. The famous Coldrum burial-place was visited, and a description given by Mr. W. H. Cook. Halling burial-place followed, where the site was shown from which the only Aurignacian skeleton found in this country was exhumed, and where true implements of that culture were found. In the evening a lecture by Mr. Reginald A. Smith, of the British Museum, was delivered on "Prehistoric Man in Kent." The most ancient remains, those found by Benjamin Harrison, of Ightham, are well represented in the Maidstone Museum.

On the morning of the last day of the meeting, a masterly address was given by Prof. E. B. Poulton on "Recent Advances and Discoveries in the Study of Entomology." The afternoon was devoted to visiting various megalithic remains in the district. The "Countless" Stones proved of great interest. They consist of about twenty large and small stones, and appear to be the thrown-down remains of more than one dolmen, or, as was suggested, of a double row of standing stones. Some of them are sarsens, but the majority are apparently Greensand or Wealden sandstones. An old record was found, showing that they were thrown down by a farmer by the aid of gunpowder towards the end of the eighteenth century. Kits Coty House was next seen, and a description given by Mr. W. Dale. The "house" is fenced round and is now safely looked after by the Office of Works. The stones are probably sarsens and have been shaped to the necessary requirements of the builders. Discussion ensued as to the origin of the name the dolmen bears. The guide-book derivation from Catigern was not thought quite satisfactory. It is said that a shepherd named Kit made it his dwelling, and it may once have been Kit's Cottage. The so-called White Horse Stone was then visited, another sarsen about which some fantastic romance has been weaved. A noticeable point about these megaliths is that they bear many cup-shaped hollows, but geologists agree that these may be due entirely to weathering. *Helix lapicida* was found on the White Horse Stone.

The Congress was very successfully carried through, and the local secretaries, Messrs. W. H. Day and J. W. Bridge, were congratulated upon the arrangements they had made.

The Constitution of the Alloys of Iron and Nickel.

THE joint paper by Dr. Hanson, of the National Physical Laboratory, and Mr. J. R. Freeman, jun., of the United States Bureau of Standards, on the above subject, presented at the May meeting of the Iron and Steel Institute, is one of great value. Of the elements used for alloying with iron for scientific and industrial purposes, none is more important than nickel. Moreover, the fact that it is an invariable constituent of meteoric iron, which may be regarded as a natural nickel-iron alloy, has invested the question of the equilibrium of these two elements with a high degree of interest. Its determination, however, has presented serious problems, due, on one hand, to the high melting ranges of the alloys and consequent pyrometric difficulties, and, on the other hand, to the difficulty of preparing the alloys free from carbon. Three years ago Dr. and Mrs. Hanson carried out a revision of the constitution of these alloys at temperatures below 900° C. The present publication completes this work right up to the liquidus of the system.

The alloys were prepared by melting the purest materials available in a "carbon ring" furnace; 50-gram melts were made in crucibles of fused alumina enclosed in a refractory muffle made of a mixture of China clay with 10 per cent. of alumina. Purified nitrogen was passed into the muffle to prevent oxidation of the melt. In taking cooling curves the melts were inoculated by means of a sawdust of iron or nickel for the pure metals or a mixture of the two for the alloys, which prevented supercooling. Platinum rhodium thermo-couples suitably protected were used for determining the temperatures, but they rapidly deteriorated with use, and in the case of the alloys rich in iron, possessing the highest melting points of the series, it was necessary to discard from one to two inches of the wire at the bulb end after each determination and remake the junction. The authors succeeded in keeping errors in temperature measurement, due to couple contamination, within 2°.

The results are shown in diagrammatic form in Fig. 1. It will be seen that, starting from pure iron, the liquidus curve drops from 1530° to 1502° at a concentration of about 5·8 per cent. of nickel. Over this range δ iron separates. The solidus is the line AEB. Within this triangle liquid and crystals co-exist. The area AEG represents the limits of existence of δ iron. Below G δ iron inverts to γ. It is somewhat remarkable that this transformation is rapidly raised by the addition of nickel, as shown by the line GE, and 3 per cent. of this element is sufficient to raise the transformation point by 100°. The line EFB represents the equilibrium between δ iron, γ iron and liquid, and its meaning may be expressed in the following way:—Solid E (δ iron) + liquid (B) react to form solid F (γ iron). The exact position of the point F has not yet been determined. The experiments thus indicate that the maximum solubility of nickel in δ iron is 3 per cent, and that this occurs at a temperature of about 1500°.

To the right of B there is an entirely different state of affairs. The liquidus curve drops continuously and much more slowly than hitherto from B to a minimum at C (1436° C.), the trough being very shallow, and then rises continuously to D, the melting point of pure nickel (1452° C.). Over the whole of this range there is complete miscibility between the metals in the solid state. Nickel, therefore, is much more soluble in γ than in δ iron, and the alloys consist when just solid of a continuous series of solid solutions. The solidus between B and D has, however, not been determined by experiments and is shown dotted. The authors state, however, that it is very close to the liquidus line, and throughout the range from B to D, all the alloys have very sharp freezing points similar to those of pure substances. Clearly, therefore, the temperature range between the liquidus and solidus is very small.

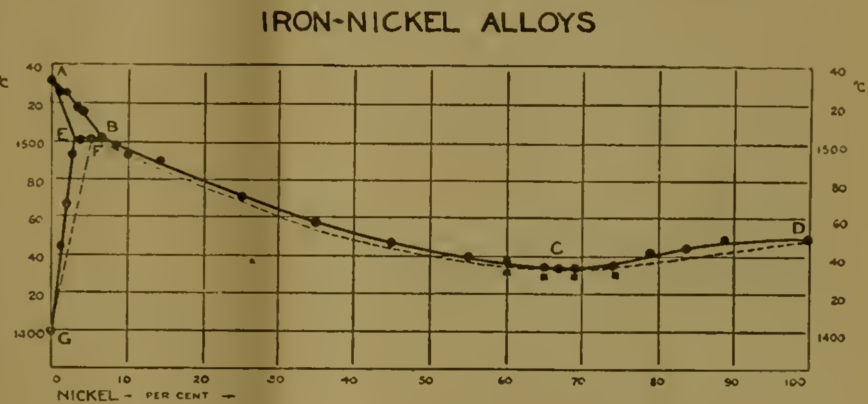

FIG. 1.

It is always difficult to determine the exact position of the minimum point of two curves of shallow inclination, and between 65 and 70 per cent the freezing point curve was found to be approximately constant, so that the exact location of C cannot be stated nearer than between these limits. Within the same range a second and smaller arrest point was observed between 2° and 5° below the liquidus. These are shown in the diagram. The authors have carefully tested whether these indicate the existence of a eutectic, but with negative results, and their conclusion is that C is the composition corresponding to a minimum in the freezing point of a continuous series of solid solutions.

In the latter half of the paper an account is given of attempts made to differentiate by means of the microscope between δ and γ iron, and to establish the fact that the change from one to the other is accompanied by a recrystallisation of the material. Transformations in iron and iron-nickel alloys take place so rapidly on cooling, that it is impossible to preserve by quenching the δ and γ modifications. Accordingly attempts were made to stereotype the structures existing at high temperatures by a vacuum etching of polished surfaces previously prepared. No clear indications, however, were obtained, and the surface markings on the specimens after this treatment were very complex. Experiments were carried out on polished specimens placed in narrow silica tubes filled with nitrogen at 20 mm. pressure, which were inserted in a furnace at 1300° C. Two tubes were used. After two hours at the above temperature, one of them was removed and cooled quickly, the other was raised rapidly to 1450° C. (within the δ range) and similarly cooled. On examination, a striking difference in structure between the two was found, constituting evidence that there is a distinct change in crystal structure at the δ to γ transformation. This may be regarded as a confirmation of Westgren's conclusion,[1] based on X-ray analysis, that δ and γ iron are constitutionally different. He found that the former has a body-centred and the latter a face-centred cubic lattice. H. C. H. C.

[1] Journal of the Iron and Steel Institute, 1922, No. 1, p. 241, and NATURE, June 24, 1922, p. 817.

The Indian Eclipse Expedition, 1922.[1]

THE story of an expedition to observe the total eclipse of the sun, seen under the most perfect atmospheric conditions, but which failed to achieve any results, is described by Mr. Evershed in the report before us. Mr. Evershed's programme was of a high-class order, and those who know him and his great ingenuity in the construction and manipulation of astronomical apparatus will share his regret at his extreme misfortune on this occasion.

Originally Mr. Evershed proposed to occupy the Maldive Islands as his observing station, but, owing to difficulties of transportation, he and his party went to Wallal, near Broome, situated on the north-west coast of Australia, and joined Dr. Campbell's expedition. For the Einstein effect he took out with him a 12-inch photo-visual lens particularly well adapted for this problem, giving, as he states, "a large field of good definition and a larger scale than the lenses used previously, or that would be likely to be used by other expeditions." It was worked in conjunction with a 16-inch cœlostat, and it was the erratic behaviour of this instrument that spoilt the results. In spite of constructing a new tangent screw and refiguring the teeth of the driving sector to secure better driving qualities, the fifteen seconds exposure plates showed movement of the star images and poor definition of the corona due to the bad driving of the cœlostat. Two short exposure plates were badly fogged "in some unexplained way" over two-thirds of the surface, but otherwise the remaining portion showed the ends of the coronal streamers beautifully defined.

The second main effort of the expedition was to photograph with large dispersion the spectrum of the corona on the east and west limbs simultaneously, in order to determine the displacement of the green corona line due to the solar rotation, and to secure a more accurate wave-length of this line. Here again disappointment was experienced, for the corona line did not appear at all on any of the plates owing, probably, to the unusual faintness of this radiation at this eclipse. Perhaps Mr. Evershed rather courted disaster on this occasion, as it is generally conceded that during the time at and near a minimum of solar activity this radiation is also near a minimum of brightness.

It will be remembered that the Greenwich expedition to Christmas Island purposely eliminated the use of a cœlostat in its work by taking out a complete equatorial photographic telescope. This was done because experience at the eclipse of May 29, 1919, seemed to suggest that the definition of the star images on the astrographic plates was poor, owing probably to the distortion of the cœlostat mirror by the heat of the sun. Mr. Evershed's view regarding the employment of a cœlostat is that it is "good for the Einstein effect.' For only with a cœlostat is it practically possible to get an adequate scale." That he is emphatic on the point is shown by his statement that "the question of the cœlostat mirror introducing complications is, I think, a bogy. Plane mirrors can now be constructed of large size and perfect figure, and experience with mirrors, good and bad, has shown that little is to be feared from distortion of the surface when the silvering is fresh and good, and simple precautions are taken."

In the opinion of the present writer, the great drawback to the use of a mirror during eclipses, whether mounted as a cœlostat or siderostat, is due to the change of figure of the plane surface of the mirror, which causes an alteration in the position of the focus of the object glass. On many occasions during eclipse expeditions, although extreme care had been taken to secure a "perfect" focus on star spectra at night (the mirror then being comparatively cool), the focus was quite different for the solar spectrum during the daytime. Thus during eclipse work it was always found most necessary to watch very carefully the disappearing crescent of the sun on the ground glass almost right up to the time of totality, and if necessary alter the position of focus accordingly.[2]

It is satisfactory to note that Mr. Evershed did not return to India with an empty bag. During a short stay at Broome on the return journey he set up the 16-inch siderostat and 12-inch lens and succeeded in obtaining a good high dispersion spectrum of Canopus and Achernar to use in connexion with his work on the spectrum of Sirius.

During this expedition Mr. Evershed was ably assisted by Mrs. Evershed and by Mr. Everson of the physics department of the University of Western Australia. WILLIAM J. S. LOCKYER.

[1] Report of the Indian Eclipse Expedition to Wallal, Western Australia, by J. Evershed, F.R.S. (Kodaikanal Observatory, Bulletin No. 72.)

[2] See Phil. Trans. Roy. Soc. A, vol. 198, p. 406.

Liberal Education in Secondary Schools.

ON Saturday, June 9, a conference of educationists in Yorkshire was held in the University of Leeds under the presidency of the vice-chancellor, Sir Michael Sadler, in response to a widespread desire to discuss certain questions affecting the supply of full-time education for boys and girls beyond the age of eleven years, and the choice of subjects in the School Examinations. In order to make the conference widely representative of educational opinion in Yorkshire, invitations were issued to the local education authorities, the universities, the training colleges, secondary schools, associations of secondary and elementary teachers, and other persons of educational experience. Upwards of 270 representatives attended the conference and were welcomed by the pro-chancellor, Mr. E. G. Arnold.

In an introductory speech, the chairman referred to the growing desire for wider opportunities of a liberal education in various parts of the world. This desire cannot be wholly explained as due to self-regarding motives. Ambition for advancement is no doubt a strong motive, but is not in itself blameworthy, especially when cherished by parents for their children. Sir Michael Sadler believes the movement has its counterpart in the movement towards greater freedom in self-government, and its deepest sources lie in a desire for liberty and the more generous development of human personality. Enlightenment and self-discipline are the two inseparable sides of a true liberal education. The force behind the desire for such an education is so powerful that it is the part of wisdom not to disregard it. He thinks that a liberal education begins away back in elementary education and extends beyond the limits of university education; that some of its indispensable factors cannot be tested by examination; and that it may be secured through diverse curricula, provided that in every curriculum a humanising spirit prevails.

Certain resolutions were thereafter submitted to the conference. After a lengthy and interesting discussion, in which a large number of delegates took part, the following motion was adopted: "That representations be made to the Board of Education urging the pressing need of further provision (by legislative change, if necessary) for the full-time education of boys and girls up to the age of sixteen, to include instruction of varying types." To this was added an addendum in favour of the pressing need of joint action between elementary and secondary branches of the Board of Education with the view of such provision and the closer combination of elementary and higher education. It is perfectly evident that there exists a large body of opinion in Yorkshire strongly in favour of greater facilities for education beyond the age of eleven and up to the age of sixteen. It is not so clear that opinion has definitely crystallised out as to the form this education should take. County Alderman Jackson, chairman of the West Riding Education Committee, expressed the opinion that the atmosphere of the mine and factory is not suitable for children between fourteen and sixteen; at that age they should be in cultured surroundings, and without doubt he expressed the views of an overwhelming majority of those present.

On the question of greater variety in curricula a discussion arose as to the desirability or otherwise of creating a new type of school in which instruction might be given of a kind different from that now normally offered in the secondary school. It was argued with some cogency that such a school might come to be looked upon as a school inferior in grade, providing an education of an inferior type, notwithstanding the suitability of the courses of instruction provided by it for the particular purpose. There is the danger, too, of segregating one class of children. Undoubtedly the great bulk of the pupils who would attend such schools would be drawn from the elementary schools. It is quite evident that many members of the conference would view with disfavour any further differentiation of schools while accepting the principle of greater differentiation of curricula. Obviously to them the logical position is to demand a common name for all full-time education, whatever its type, between the ages of eleven and sixteen.

Sir Henry Hadow, vice-chancellor of the University of Sheffield, in an interesting speech introduced a motion which, while welcoming the greater freedom in the choice of subjects for the First School Examinations now allowed by the Joint Matriculation Board of the Northern Universities, expressed the opinion that there should be greater freedom in regard to the groupings of courses for the Higher Certificate. The motion was agreed to unanimously.

Rothamsted Experimental Station.

Annual Visitation.

At the invitation of Lord Bledisloe, chairman of the Lawes Agricultural Trust Committee, a number of guests representing various agricultural interests visited the Rothamsted Experimental Station on Wednesday, June 13, for the annual inspection of the fields and laboratories.

The morning was occupied in a tour of some of the experimental plots, including two of the classical fields—Broadbalk, on which wheat is grown continuously, and Hoos, where barley is similarly grown. These have been for many years of the utmost value and interest to agriculturists in general, and the opportunity was taken to show the visitors some of the other plots laid down to test points that had, directly and indirectly, arisen from the results of these classical experiments. Among these may be mentioned the top-dressing series, designed to ascertain how the yield of the crop is influenced by spring dressings of artificial fertilisers applied in varying amounts and at various times; the malting barley series, in which the relation between malting value and manurial treatment is being examined; and the residual value of different manures on the succeeding crops. On this latter field the crop this year is clover, and the beneficial effect of previous organic manures, in particular cake-fed dung, is most striking.

After luncheon Lord Bledisloe briefly reviewed the purpose and recent progress of the Station. He laid stress on the care that is taken to avoid the erection of water-tight partitions between the scientific worker and the practical farmer, without in any way limiting the work of fundamental investigation, on which the application of science to agriculture is of necessity founded. Lord Bledisloe also referred to a number of the external activities of the Station, as indicative of the efforts made to keep in touch with the whole life of the countryside.

Sir E. J. Russell, director of the Station, then gave his statement on the work of the Station during the past year. The reorganisation of the laboratories has been completed, and the experimental work on the farm will shortly follow suit. Very considerable progress has been made in extending the outside centres: the experimental fields on the Woburn Farm are now in charge of Rothamsted, and Dr. Voelcker, who for many years has been in charge at Woburn, has consented to continue the work. Through the generosity of Mr. E. D. Simon, the use of an extensive farm—Leadon Court, Herefordshire—has been given to the Station, and under the management of Mr. J. C. Brown an extensive trial of the soiling system is being carried out. In addition, the Station has many centres on farms throughout the country, at each of which a repetition of a carefully designed experimental programme is being carried out. By this means it is possible in a comparatively short time to obtain trustworthy information on the degree to which the results of field trials at Rothamsted are modified at centres possessing different soil and climatic conditions. The work is being carried out at present on malting barley and potatoes with especial reference to the action of artificial fertilisers, and wherever possible the aid and support of the industrial organisations concerned have been enlisted.

Passing on to the work in progress in the laboratories, Sir John discussed it under its three main headings,—the cultivation of the soil, the feeding of the crops, and the maintenance of healthy conditions of plant work. In connexion with the work on soil cultivation and the physical properties of the soil, he stated that the Empire Cotton-growing Corporation has given a substantial sum for the development of this work, as it is convinced that questions of soil physics are of great importance in those parts of the Empire where cotton is grown. Among other recent developments are apicultural investigations and work on the control of insect pests by means of parasites. The New Zealand Government has been supplied with parasites of certain pests,—the earwig, pear slug larvæ, and pear leaf midge,—which cause extensive damage in that country.

Sir Matthew Wallace also spoke of the value of the work at Rothamsted to the practical farmer. He compared the present wave of agricultural depression with that of 1880 when he started farming, and said that the comparison made him optimistic for the future. The close relations that must exist between research centres and agricultural colleges if both are to keep ahead of the times were alluded to by Principal M. J. R. Dunstan, of the Royal Agricultural College, Cirencester. Mr. George Dallas, of the Workers' Union, said he was very greatly encouraged by the attention now being devoted by the Ministry of Agriculture and Stations like Rothamsted to the improvement of the lot of the farm labourer. He expressed the opinion that the recent increase of educational facilities will be of great benefit to the whole industry, and further it will help to prevent the departure of the best and keenest men from the land.

In the afternoon the visitors made a brief inspection of the work in progress in the laboratories.

New Principle of Therapeutic Inoculation.

In collaboration with L. Colebrook and E. J. Storer, Sir Almroth Wright published in the *Lancet* (February 24, March 3 and 10) an elaborate communication which is an expansion of a special lecture delivered before the Royal Society of Medicine in November 30, 1922. It is entitled "New Principles of Therapeutic Inoculation."

The new principles may be best understood by a brief reference to the older principles which they are intended to augment or replace. In the therapeutic inoculation for infective disease, it has hitherto been the custom, following Sir Almroth Wright's earlier work, to inoculate the infected individual with a vaccine prepared with the virus with which the individual is infected. While the results in chronic infections have been on the whole excellent, there has been disappointment in the cases in which a heavy infection of a septicæmic type occurred. This was due to a certain extent to the fact that the elaboration of specific protective substances was a matter of time, and the state of the individual might be such that he was incapable of elaborating protective substances at all.

For a long time, however, it was known that non-specific bacteria, or indeed substances not bacterial in origin at all, might be employed to augment quickly the patient's resistance by a process, it was thought, of leucocytosis and phagocytosis. While not agreeing with this suggested action, Sir Almroth Wright, by many new and ingenious technical methods, shows that what he calls an "epiphylactic" response may be evoked by bacteria which are not identical with those with which the patient is infected. This epiphylactic response occurs when inoculation is made into the blood *in vivo* or even *in vitro*, and takes place immediately by an extrusion of opsonic and bactericidal elements from the leucocytes—an ectocytic rather than a phagocytic process. These ectocytic substances are polytropic in character, *i.e.* they act not only on the homologous but also on heterologous bacteria.

There is, in fact, a non-specific immunity, and it is this which Wright and his collaborators aim at producing to tide the patient over the critical days of his severe infection. The process adopted is named "immuno-transfusion," and consists of the incorporation of healthy human blood which *in vivo* or *in vitro* has been made, by inoculation, to develop an adequate epiphylactic response and is laden with protective substances. In this process it is clearly pointed out that quantitative determinations are of the utmost importance, as a dose of antigen optimal for one patient may be highly detrimental for another. The methods recommended are complicated, and treatment of severe cases of generalised sepsis, if it is to be successful, must lie in the hands of highly trained serologists.

University and Educational Intelligence.

Aberdeen.—The Blackwell prize for 1923 has been awarded to Mr. F. C. Diack, the subject of the essay being "The Sculptured and Inscribed Stones of the North-east and North of Scotland."

The University Court has appointed the following lecturers to the newly instituted grade of reader in their respective subjects: Geography, Mr. J. M'Farlane; bacteriology, Dr. J. Cruickshank; public health, Dr. J. P. Kinloch; embryology, Dr. A. Low.

Prof. C. R. Marshall has been appointed John Farquhar Thomson lecturer on "The Human Body" for the year 1923–4.

Cambridge.—Mr. J. Barcroft, King's College, Dr. Adrian, Trinity College, and Dr. Hartridge, King's College, have been reappointed reader in physiology, University lecturer in physiology, and University lecturer in the physiology of the senses respectively; Mr. A. H. Peake, St. John's College, and Mr. T. Peel, Magdalene College, have been reappointed as demonstrators of mechanism and applied mechanics. Senior studentships have been awarded by the Royal Commissioners for the Exhibition of 1851 to D. Stockdale, King's College, and J. H. Quastel, Trinity College.

Sheffield.—An anonymous gift of 20,000*l.* has been accepted by the University for the purpose of founding an undergraduate scholarship and a number of post-graduate scholarships. The undergraduate scholarship is to be in the faculty of pure science, and is restricted to boys from King Edward VII. School, Sheffield. The post-graduate scholarships are to enable graduates to pursue research in ferrous or non-ferrous metallurgy.

At a meeting of the trustees of the Albert Kahn Travelling Fellowships Foundation on June 14, Mr. W. Randerson was elected to the fellowship for 1923. Mr. Randerson was educated at the Imperial College of Science, South Kensington, and during this year has been a research fellow of the Salters' Institute of Industrial Chemistry; recently he obtained the degree of M.Sc. (London) for a thesis on the chemistry of the soil solution. The value of the award, which is to enable a student of proved intellectual attainment to enjoy a year's travel for research, is again to be 1000*l*.

THE British Research Association for the Woollen and Worsted Industries is to award shortly a number of research fellowships and advanced scholarships. The fellowships, which are tenable in the first place for one year, are of the annual value of 200*l*. The advanced scholarships, also of one year's tenure, carry a maintenance grant, and are designed to afford opportunity for specialisation. They are tenable either in Great Britain or abroad. Applications for fellowships must reach the secretary of the Association at Torridon, Headingley, Leeds, before July 21, and should contain particulars of the candidate's training and experience.

AN article by Mr. H. A. L. Fisher in the *Empire Review* for June surveys the progress of education in the Empire since 1911, the date of the last Imperial Educational Conference. It has been marked in the Dominions by a development of university and college influence even more remarkable than the similar development in Great Britain, and by a quite noticeable family resemblance between the expedients adopted in the various parts of the Empire for dealing with school and college problems. As examples of this resemblance he cites the Ontario Continuation Schools enactment modelled on the British Act of 1918, the raising of the school age in Alberta to 15, Tasmania's new separate infant department, and Queensland's extended scheme of medical inspection. There has been likewise a very general augmentation of teachers' salaries, but this has failed conspicuously to meet the needs of the situation in sparsely populated tracts of country. The Director of Education in Manitoba writes of inexperienced girls placed in charge of district schools because capable men willing to accept such posts can no longer be found. Australia organises either correspondence classes or itinerant teaching. New Zealand employs group supervising teachers. In Canada, as in the United States, there has been an important movement in the direction of concentrating children of rural areas in central schools. Mr. Fisher concludes his article with a prophecy that during the next decade the four most important tasks will be the development of adolescent education in Great Britain, the strengthening of the Arts Faculties in Canadian universities in such a way as to save these institutions from degenerating into mere groups of professional schools with predominantly materialistic motives, the raising of the matriculation age in India, and "such reforms (including in the first place the geographical concentration of the higher teaching in the Arts and in Pure Science) as may enable London University to take its rightful place as one of the great High Schools of the Empire."

IN a paper on methods of college teaching read to the Association of Land Grant Colleges of America, an interesting sketch was given by Dr. W. W. Charters of experiments carried out by him as professor of education in the Carnegie Institute of Technology. When he joined the Institute some three years ago he found that while many of the experienced teachers in the four divisions—Engineering, Industries, Fine Arts, and Women's College — had worked out excellent methods of teaching by themselves, many of the younger members of the staff, who had had no specific and formal training in methods, needed guidance which it became his duty to provide. Finding nothing for the purpose in books on teaching methods, the authors of which concern themselves almost exclusively with elementary and secondary education, he organised a weekly seminar and made the instructors who enrolled for it draw up lists of their duties and difficulties. He thus obtained a list of 14 real practical difficulties. He next made a list of 30 of the best teachers in the faculty, and the members of his seminar class were let loose on the chosen 30 to wrest from them the secret of how to handle the 14 difficulties. The professors surrendered at discretion, and the storm troops returned stimulated by the encounters and laden with intellectual spoil, which they proceeded to hammer out into a pamphlet which has been in use ever since. In the following year in the course of a similar campaign, undertaken with the object of elucidating the difficulties of getting students to think, it was found that inductive sciences such as chemistry and physics afforded less opportunity than others for practice in reasoning. This was attributed to the technique of investigation being so refined and the equipment so elaborate that principles have to be for the most part merely verified by students without being re-discovered. In the third year difficulties in shop and laboratory teaching were dealt with. Great stress is laid by Dr. Charters on the value of the weekly seminar for inexperienced teachers, to be followed when practicable by criticism of actual performances.

THE report for 1921–22 of the Commissioner of Education of the United States, who, by the way, is an old Rhodes scholar and graduate of Oxford, shows that if the Federal Government's appropriation for his Bureau—the Education Office of the Department of the Interior—is, as he says, "infinitesimal," it is nevertheless made to go a long way. Education in the States enjoys the ministrations of 48 Boards of Education or their equivalents, each of the sovereign States determining for itself the amount and character of the instruction provided for the children of its citizens: "This is as it should be, for the genius of the American people will probably never accept the idea of a centralized national system of public schools." In the circumstances invaluable service can be rendered by an unbiased, disinterested agency which "makes available to all the States the experiences of the most progressive and the achievements of the most highly endowed." Of the services rendered by the Bureau the conduct of surveys of State school systems and of universities and colleges, whether individually or by groups, is, the Commissioner says, probably the most far-reaching in effect. This work has grown very rapidly during the past two years. Among the developments recorded are: the new radio broadcasting service, which, as a means of reaching the general public, particularly parents and taxpayers, has proved cheaper than printing, reaches its audience quicker, reaches the mass of people who will not read printed articles, is more effective because it establishes more intimate contact, and, above all, educates public opinion *continuously*; promoting co-ordination of schools of commerce with schools of engineering with the view of improving methods of marketing at home and abroad; stimulating special training for foreign service, both Government and commercial; organising home-reading circles on the lines of the National Home Reading Union in Great Britain and associations of parents and teachers. Of interchange of students between countries the Commissioner says, "It is a desirable practice making for permanent peace and international comity, and is encouraged by every progressive nation. There are at least 10,000 foreign students in our institutions of higher learning and probably as many more in secondary schools."

Societies and Academies.

LONDON.

Royal Society, June 14.—C. **Chree**: Magnetic phenomena in the region of the south magnetic pole. Magnetographs were in simultaneous operation from April to October 1912, at the base stations of the British and Australasian Antarctic expeditions on opposite sides of the south magnetic pole. A comparison is made of the regular diurnal inequalities and the amplitudes of the absolute daily ranges of the magnetic elements at the two stations. The data show the remarkable sensitiveness of the regular diurnal variations in high latitudes to the presence of magnetic disturbance. The results are also applied to the question of a suitable criterion for the daily activity of magnetic disturbance.—O. R. **Howell**: The catalytic decomposition of sodium hypochlorite by cobalt peroxide. The rate of decomposition of sodium hypochlorite solution by cobalt peroxide is directly proportional to the amount of peroxide present. It is accelerated by sodium salts and (in the case of sodium chloride) is directly proportional to the square root of the concentration of sodium ions present. The mechanism of the reaction probably consists in the linkage of hypochlorite ions to the positive oxygen, and sodium ions to the negative oxygen of the peroxide, with immediate decomposition of the quadrivalent oxygen compound. With a fixed amount of hypochlorite the rate is then proportional to the degree of adsorption of the sodium ions. The rate is retarded by alkali and the retardation is proportional to the adsorption of hydroxyl ions. The average temperature coefficient of the reaction between 25° and 50° is 2·37 and the Arrhenius activation coefficient E is 16,574. The catalyst is not affected by any of the common catalytic poisons.—N. M. **Hosali**: On seismic waves in a visco-elastic earth. Seismic waves are subject to damping and dispersion dependent on the period. For each type of wave—dilatational, distortional, or surface—there exists a minimum period below which a wave cannot be transmitted, and for any period above the minimum two distinct waves can be propagated, one heavily damped and slow travelling and one lightly damped and quick travelling. Observations indicate that if the material in the outer layers of the earth obey the theory here developed it should have a viscosity of order 10^8 or 10^9 C.G.S. units. This would have no appreciable effect on the velocity of propagation of earthquake waves.—J. W. **Landon** and H. **Quinney**: Experiments with the Hopkinson pressure bar. With a bar of uniform diameter the pressure wave produced by detonation of gun-cotton is considerably distorted as it is propagated, but the rate of distortion decreases as the wave travels along the bar. Pressure falls away rapidly as distance from the axis of the bar increases. To determine the maximum pressure produced in the detonation of gun-cotton the bars were submitted to special heat treatment in the hope that overstrain might be reduced. A substantial improvement was observed except in so far as the life of the bars was increased. The highest maximum pressures recorded were 117 tons per square inch for a 1-ounce gun-cotton primer in contact with the end of the bar, and 82 tons per square inch with the primer $\frac{3}{4}$ inch away from the end. These results were obtained with a short bar of $\frac{3}{4}$-inch diameter. With concrete bars the phenomena exhibited are the same in general as with steel bars, except that the front of the wave appears to be entirely obliterated, and only the part in which pressure is less than the crushing stress of the concrete is propagated along the bar.—S. F. **Grace**: Free motion of a sphere in a rotating liquid at right angles to the axis of rotation. The density of the sphere is equal to that of the liquid, and the motion a small disturbance from one of uniform rotation like a rigid body. The motion of the centre of the sphere is wholly in a plane perpendicular to the axis of rotation, and the disturbed motion of the liquid is symmetrical with respect to this plane. The path of the centre of the sphere is a spiral with a definite pole. The sphere winds round the pole in a direction opposite to that of the rotation of the liquid, the motion being such that the time of a complete turn tends to become constant and equal to one-half the time of a revolution of the undisturbed liquid. At points along the prolongation of the polar axis of the sphere the motion is parallel to the equatorial plane and is a maximum at the sphere. Parts of the solution are not applicable for large values of time.—B. F. J. **Schonland**: The passage of cathode rays through matter. The absorption of cathode rays of velocity 6×10^9-$1{\cdot}2\times10^{10}$ cm./sec. in various metals has been studied with an arrangement designed to eliminate interference from secondary rays and to measure both the fraction of the beam passed through and that actually absorbed in the foil. The latter fraction varies with thickness and velocity in the same manner for all elements; the nature of the variation of the former depends upon the absorbing material. The results are explained by applying the theory of absorption due to Bohr, with which they are in quantitative agreement.

Association of Economic Biologists, April 27.—C. M. **Wenyon**: Recent observations on parasitic Protozoa in animals and plants. Certain parasitic Protozoa, such as the Coccidia, and some Hæmogregarines, which are inhabitants of the intestinal canal or wall of the intestine of vertebrates, and pass from host to host in the encysted form which escapes in the dejecta, have become so modified in the course of evolution, that they are no longer transmitted by means of cysts but are carried by bloodsucking invertebrates. It is probable that the well-known parasites of malaria are modified Coccidia. Intestinal flagellates, such as Trichomonas, which are normally inhabitants of the lumen of the intestine, may occasionally enter the blood stream. Reichenow has shown that in the lizard the entry of the intestinal flagellate Eutrichomastix into the blood may lead to infection of the mites, which again give rise to an intestinal infection of lizards which devour them. Similarly flagellates of insects like the flea or flies which usually live only in the invertebrate, may establish themselves in the intestines of vertebrates which eat them. Thence they may invade the blood of the vertebrate and are undoubtedly ingested by blood-sucking insects. It is possible that the parasite of the disease "Kala azar" of man may be an insect flagellate which enters man by way of the mouth, gains access to his intestine, and thence invades his tissues. Plants may be infected in like manner, for flagellates of the typically insect type have been found in various species of Euphorbia and other plants, and it has been shown by Franca that they are derived from bugs which feed upon the plants. M. S. G. **Breeze**: Some causes of sterility in Solanaceous plants due to Protozoa and Chytridiaceous parasites. The plants investigated were varieties of potato and petunia, and the following points were noted: (1) An Amœba, similar to *Amœba gleba*, attacks potato flowers virulently though without any outward sign. The tissues are hypertrophied and turgid. (2) Chytridiaceous zoospores (probably synchytrian) occur in anthers in half-grown buds of Up-to-Date potatoes damaged by the Amœba; and some of the Amœbæ may migrate to the adjacent ovarian tissue; the zoospores swim to and fro by an anteriorly directed flagellum. Associated with the above is a spore-bearing bacillus with rounded ends, probably a saprophyte. (3) "Bird's eye" bodies in petunia and potato ovaries are regarded as possibly a phase of (2), and therefore synchytrian parasites.

Zoological Society, May 29.—Dr. A. Smith Woodward, vice-president, in the chair.—C. Tate **Regan**: (1) Some deep-sea fishes taken by the *Dana* Expedition, under the leadership of Dr. Johannes Schmidt. The fishes belong to the very rare and little-known genera Gigantena and Stylophorus, which agree in having telescopic eyes placed close together and directed forwards. (2) The skeleton of Lepidosteus, with remarks on the origin and evolution of the lower neopterygian fishes.—C. F. **Sonntag**: The comparative anatomy of the tongues of the mammalia.—IX. Edentata, Demoptera, and Insectivora.—S. **Maulik**: New cryptosome beetles.

Paris.

Academy of Sciences, May 28.—M. Albin Haller in the chair.—Charles **Moureu**, Charles **Dufraisse**, and Ph. **Landrieu**: The principle of a general method for determining the calorific capacity of solids and liquids. Application to the determination of the water equivalent of calorimetric bombs.—P. **Villard**: A hydrate of iodine. Iodine and water, compressed with oxygen or nitrogen to 150 atmospheres, give crystals of a hydrate of iodine. The crystals are crimson-violet, strongly contrasting with the brown colour of the aqueous solution of iodine.—M. **Wallerant**: Extract from a note of M. Astbury. The structure of the crystal of tartaric acid, determined by the X-ray method, is in agreement with the views expressed by Pasteur in 1860.—Charles **Depéret**: The glaciations of the valleys of the French Pyrenees, and their relations with the fluvial terraces. From observations in the Ariège, Garonne, Neste, Aure, Gare de Pau, and Gare d'Ossau, there is complete identity between the Alps and Pyrenees for the number and periods of extension of the quaternary glaciers.—M. Henri Villat was elected a corresponding member for the section of mechanics in the place of the late R. Ariès.—René **Garnier**: Uniform functions of two independent variables defined by the inversion of an algebraic system of total differentials of the fourth order.—N. **Saltykow**: The methods of integration of partial equations.—M. **Angelesco**: Certain biorthogonal polynomials.—H. **Milloux**: Infinite series of functions and meromorphic functions with asymptotic value.—Charles N. **Moore**: The generalised Fourier series of non-integrable functions.—J. **Haag**: The problem of Schwarzschild in the case of a curved universe.—F. **Gossot** and R. **Liouville**: The principles of internal ballistics.—Jean **Chazy**: The secular effects of the theory of relativity in the planetary movements.—J. **Le Roux**: The field of gravitation.—A. **Luthy**: The ultra-violet spectrum of glyoxal. In hexane solution, this substance gives a series of narrow absorption bands in the ultra-violet; no compound of the aliphatic series has hitherto been known to give narrow absorption bands in the ultra-violet.—Guillaume C. **Lardy**: The ultra-violet absorption spectrum of diacetyl. In alcoholic solution previous observations have shown only a band in the violet and another in the middle ultra-violet. In hexane solution the author has found narrow bands. These bands are not so clearly separated as the narrow bands shown by glyoxal in the same region.—F. W. **Klingstedt**: The ultra-violet absorption spectrum of paraquinone. This substance shows in hexane solution fourteen narrow bands in the visible part of the spectrum between the green and the violet. In addition, in the middle ultra-violet there is one large band, and in the extreme ultra-violet ($\lambda = 2410$) there is one very strong band.—Albert **Colson**: Contribution to the laws of solubility.—A. Ch. **Vournazos**: The bismuthamines, a new class of bodies. These substances are obtained by the interaction of bismuth chloride (bromide or iodide) and an ammonia (or amine) salt in an organic solvent. As a typical example, the compound $BiCl_3I(NH_4)$ is obtained by the action of $BiCl_3$ on a cold solution of ammonium iodide in acetic acid. It forms silky transparent needles, decomposed by water.—Alfred **Gillet** and Fernand **Giot**: An application of the antioxygen power of the polyphenols: increase of fastness to light of dyes on the fibre. All the acid azo dyes, both on wool and on cotton, are relatively protected against the action of air under the influence of light by the *o*- or *p*-diphenol function, whether the latter is, or is not, a part of the molecule of the dye. Some eosin dyes behave similarly, but the nitro dyes, triphenylmethane derivatives, and basic colours are not protected.—Paul **Corbin** and Nicolas **Oulianoff**: Certain characters of the Hercynian fold in the Servoz-Les Houches region (Arve valley).—Conrad **Kilian**: The folds of the crystalline schists of Ahaggar; the Saharides.—René **Souèges**: The embryogeny of the Geraniaceæ. Development of the embryo in *Erodium cicutarium*.—G. **Hamel**: The limit of vegetation in the Channel according to the dredgings carried out by the *Pourquoi-Pas?* No algæ were found at depths greater than forty-five metres, and it concluded that at greater depths than this all vegetation, with the exception of diatoms, and plankton, is absent.—Jules **Stoklasa**: The origin of the nitrate deposits of Chili. According to one hypothesis, the nitrate deposits result from the accumulation of excrements and bodies of animals: another view (C. Noellner) is that the nitrates arise from the accumulation of submarine plants, since these plants contain iodine, and iodine is an invariable constituent of "caliche." The author gives reasons for regarding a volcanic origin as more probable than either of the preceding hypotheses.—J. **Lopez-Lomba** and Mme. **Randoin**: The state of scurvy produced by a complete regime in biochemical equilibrium, deprived only of the factor C.—W. **Kopaczewski**: Surface tension, swelling, and narcosis.—R. **Argaud**: The sclerogenic rôle of the giant cells.

Washington.

National Academy of Sciences (Proc. Vol. 9, No. 4, April).—R. L. **Moore**: Concerning the cut-points of continuous curves and of other closed and connected point-sets.—J. **Belling** and A. F. **Blakeslee**: The reduction division in haploid, diploid, triploid, and tetraploid Daturas. During the first division in the pollen-mother-cells of diploid, triploid, and tetraploid Daturas, homologous chromosomes are usually connected by their ends. Non-reduction occurs generally only in haploid plants. The volume of cytoplasm in the pollen-mother-cells is nearly proportional to the number of haploid groups present. T. **Ellinger**: The variation and inheritance of milk characters. The records of a herd of 700 cows at Tranekjaer

Castle, Denmark, which consisted originally of Red Danish dairy cattle and Jersey cattle, are discussed. The yield during the first 10-week period of milking appears to be the most trustworthy measure of a cow's milk-yielding qualities. The records of the cross-bred cattle (F_1) show no indication of any single Mendelian factor in the inheritance of milk characters.—A. R. **Olson** and G. **Glockler** : The critical and dissociation potentials of hydrogen. A heated platinum filament covered with calcium oxide in a vacuum tube containing purified dry hydrogen at 0·1 mm. of mercury pressure was used as the source of electrons. The beam of electrons passed through platinum stops to which varying accelerating and retarding potentials could be given, and fell on an ionisation cylinder connected with a quadrant electrometer. The dissociation potential of hydrogen appears to be 3·16 volts; eight breaks occur in the current-potential curves, five of which correspond with lines of the Lyman series.—G. L. **Clark** and W. **Duane** : (1) The reflection by a crystal of X-rays characteristic of chemical elements in it. Crystals of the compounds KI, KI_3, CsI, CsI_3, and CsIBr have been investigated and X-rays characteristic of iodine, cæsium, and bromine have been identified which obey the regular laws of crystal reflection. The method used is to determine the position of peaks in the ionisation curve by rotating the crystal (corresponding to reflections from the various planes), and, setting the ionisation chamber at one of these peaks, to move the crystal and the ionisation chamber, the latter at twice the rate of the former. A series of peaks are obtained referring to one set of planes alone. For KI, wave-lengths of these correspond with the $K\alpha$ and $K\beta$ wave-lengths of iodine. The distance between the 100 planes is $3{\cdot}53 \times 10^{-8}$ cm. KI_3 is found to be a cube slightly distorted with the edge $4{\cdot}70 \times 10^{-8}$ cm. long. CsI_3 appears to be a rhombic crystal with cæsium atoms at each corner and iodine atoms at the centre and at points equidistant from the centre along the body diagonals. $CsIBr_2$ is also a rhombic crystal. (2) On the abnormal reflection of X-rays by crystals. Reflections of X-rays have been obtained from potassium iodide which are not in accord with the usual laws of crystal-reflection. The peaks caused in the ionisation curve are termed "X-peaks." For small deviations of the X-ray beam, the X-peak is outside that due to the 130 planes; for larger deviations, it is between those due to the 100 and 130 planes. The X-peak does not appear unless the incident beam contains X-rays of shorter wave-length than those in the K-series of iodine.—G. L. **Clark** : The significance of the experimentally determined crystal structures of the alkali polyhalides. It appears from X-ray analysis of the polyhalides KI_3, CsI_3, $CsIBr_2$, $CsICl_2$, that the three halogen atoms lie a diagonal of the crystal lattice, the heaviest in the centre; the metal atoms are at the corners. Other polyhalides are closely related chemically and crystallographically, and probably have similar structures, apparently closely related to the simple halide unit cubes, the halide group replacing a halogen atom. The size of the metal atom determines the dimensions of the unit cell and thus the relative stabilities of the polyhalides of the group.—E. B. **Wilson** : Electric conduction : Hall's theory and Perkins' phenomenon. Perkins has shown that the addition of a negative charge to a conducting strip of graphite decreases the conductivity. This is contrary to what might be expected on a free electron theory of conduction, but can be explained on Hall's theory of conduction by streams of electrons and ions, the latter taking a predominant part.

Official Publications Received.

Report of the Director of the Royal Observatory, Hongkong, for the Year 1922. Pp. 17. (Hongkong.)

Department of Commerce : U.S. Coast and Geodetic Survey. Serial No. 225 : Reconnaissance and Signal Building. By Jasper S. Bilby. (Special Publication No. 93.) Pp. v+77. (Washington : Government Printing Office.) 30 cents.

Smithsonian Institution : United States National Museum. Bulletin 100 : Contributions to the Biology of the Philippine Archipelago and Adjacent Regions : Ophiurans of the Philippine Seas and Adjacent Waters. By Prof. Rene Kœhler. Pp. x+486+103 plates. Bulletin 124 : The Type Species of the Genera of Chalcidoidea or Chalcid-Flies. By A. B. Gahan and Margaret M. Fagan. Pp. iii+173. 15 cents. (Washington : Government Printing Office.)

Report of the Aeronautical Research Institute, Tókyó Imperial University. No. 1 : Hikôki ni taisuru Kaze no Hôkô to Hayasa wo kirokusuru Kikai (An Instrument to measure the Direction and Speed of Wind relative to an Aeroplane). By Tamaru-Takuró. Pp. 23. Y. 0.50. No. 2 : A New Air Velocity Calculator. By Toyotaró Suhara. Pp. 25-31. Y. 0.70. No. 3 : On the Diurnal Variations of Winds in different Coastal Stations of Japan. By Torahiko Terada and Tatuo Kobayasi. Pp. 33-85. Y. 1.10. No. 4 : On the Decay of Vortical Motion in a Viscous Fluid. By Kwan-ichi Terazawa. Pp. 87-135. Y. 0.90. No. 5 : On the Distribution and Variation of Temperature in the Cylinder and Piston of an Aircraft Engine. By Toyotaró Suhara and Naozo Sato. Pp. 137-170. Y. 1.20. (Tókyó : Maruzen Kabusiki-Kwaisya.)

Neue Denkschriften der Schweizerischen Naturforschenden Gesellschaft (Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles). Band 53. Pp. xx+402+54. Band 54. Pp. iv+291+32 Tafeln. Band 55. Pp. viii+149. Band 56. Pp. vi+128+28 Tafeln. Band 57. Pp. xi+325. Band 58. Pp. viii+251. (Basel, Geof and Lyon : Georg and Co.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 4, 1922. 2 : Nederbörden i Sverige. Pp. 173. (Stockholm.)

Diary of Societies.

MONDAY, JUNE 25.

ROYAL SOCIETY OF BIOMETRICIANS AND MATHEMATICAL STATISTICIANS (at University College), at 8.—Dr. T. H. C. Stevenson : The Social Distribution of Causes of Death in England and Wales.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—L. E. Claremont : Case of Fibro-Cystic Disease of the Lower Jaw.—Dr. A. Hopewell-Smith : Two Odotomes ; Some Observations on the Histology and Pathology of the Dental Pulp.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presentation of the Royal Gold Medal.

TUESDAY, JUNE 26.

IMPERIAL EDUCATION CONFERENCE (at Institution of Mechanical Engineers), at 8.—Miss L. De Lissa : Recent Developments in Infant Education and their Connexion with the Work of the Elementary Schools.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—de Barri Crawshay : Exhibit of Eoliths from the South Ash Pit on the Kentish Chalk Plateau, and of Stone Implements from Mesopotamia.—S. Hazzledine Warren : The Palæolithic Succession of Stoke Newington.

SOCIOLOGICAL SOCIETY (at Royal Society), at 8.15.—Dr. E. Jenks : The Function of Law in Society.

WEDNESDAY, JUNE 27.

ROYAL SOCIETY OF ARTS, at 4.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30—Dr. W. Mayo, Sir Berkeley Moynihan, J. Sherren, G. Grey Turner, and A. J. Walton : Discussion on the Surgery of the Hepatic and Common Bile Ducts.

IMPERIAL EDUCATION CONFERENCE (at Institution of Mechanical Engineers), at 8.—Lt.-Gen. Sir Robert S. S. Baden-Powell, Bart. : The Boy Scout and Girl Guide Movement.

THURSDAY, JUNE 28.

ROYAL SOCIETY, at 4.30.—Prof. V. H. Blackman, A. T. Legg, and F. G. Gregory : The Effect of a Direct Electric Current of very Low Intensity on the Rate of Growth of the Coleoptile of Barley.—Miss R. M. Tupper-Carey and Prof. J. H. Priestley : The Composition of the Cell Wall at the Apical Meristem of Stem and Root.—L. J. Harris : The Titration of Amino- and Carboxyl-Groups in Amino-Acids, Polypeptides, etc.—Dr. M. S. Pembrey, N. W. MacKeith, W. R. Spurrell, E. C. Warner, and H. J. Westlake : Observations on the Adjustment of the Human Body to Muscular Work.—F. A. E. Crew : Studies in Intersexuality. II. Sex-Reversal in the Fowl.—Prof. W. Finkler : Analytical Studies on the Factors causing the Sexual Display in the Mountain Newt (*Triton alpestres*).—Prof. G. A. Schott : The Scattering of X- and γ-Rays by Rings of Electrons—The Effect of Damping of the Incident Radiation.—Major P. A. MacMahon : A Class of Transcendents of which the Bessel Functions are a Particular Case.—Dr. L. C. Martin : The Photometric Matching Field.—Prof. G. P. Thomson : Test of a Theory of Radiation.—Dr. A. Ll. Hughes and P. Lowe : Intensities in the Helium Spectrum.—A. A. Dee : The Effect of Quenching from above the Carbide Transition Temperature upon the Magnetism of Steel.—T. S. P. Strangeways and H. E. H. Oakley : The Immediate Changes observed in Tissue Cells after Exposure to Soft X-Rays while growing *in vitro*.

INSTITUTION OF ELECTRICAL ENGINEERS (at British Museum (Natural History)), at 8.30.—Annual Conversazione.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Prof. C. G. Cumston : Certain Points in Connexion with Nephritis.

FRIDAY, JUNE 29.

SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE (British Section) (at Institution of Mechanical Engineers), at 8.30.—M. Barrillon : The Port of Rouen and the Lower Seine.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" *To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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CONTENTS.

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Position and Needs of the Science Museum Collections.

IN an article in another part of this issue an outline is given of the present state of advancement of the Museum building scheme at South Kensington, which was approved in 1912 and started in 1913. The scheme was that which the Departmental Committee on the Science Museum and the Geological Museum proposed in its Report of 1911 and 1912 as to (1) the purposes these museums should serve in the national interests; (2) the nature, arrangement, and development of the collections required for these purposes; and (3) the buildings required on the South Kensington site to house these collections. This was a logical reference, and the report dealt with it faithfully and effectively.

The discussion of the reference inevitably brought the reporting committee face to face with the problem of co-ordinating these two museums with one another and with the Natural History Museum. The committee found that there was in practice little or no overlapping of the fields of the three museums, and in the end it was able to formulate proposals by which the buildings of the three museums would be brought into direct communication. Thus the related parts of the great national collections in the sections of science concerned would be brought into a continuous series.

Under the scheme thus initiated, the individuality of the several museums and their administration under their existing responsible authorities would not be affected in any way; at the same time the group of museums would afford at a single centre, and in intercommunicating buildings, a real national museum representative of science. This feature of the recommendations of the committee was made possible by an arrangement with the Trustees of the British Museum, who were willing that the new Geological Museum building should be placed on a part of the ground allotted to the Natural History Museum, and should be a part, structurally, of the eastern extension of the Natural History Museum building.

The scheme is an admirable one. It provides for the mineral products of the earth complete museum representation as to natural history, geological structure, economic conditions, mining, metallurgy, and all physical and engineering investigations and appliances bearing on these. Further, it suggests lines for obtaining similar advantages in relation to other branches of science as the scheme comes to be applied in later stages.

The first item of the scheme was the erection of the Eastern Block of the new Science Museum, and this has shown so little progress since the War that the councils of a number of leading scientific and technical societies have found it necessary to direct attention to the matter and to ask that the building be expedited. In these times of financial straits it has been a national necessity to go slowly in the matter of new public buildings, and precedence in such work must be most carefully considered. In recent years few things have been so generally and so fully recognised as the magnitude of the contributions which physical and mechanical science have made to the progress of the country in knowledge, in industries, in trade, and in war, and accordingly it might have been assumed that the work on the Science Museum building, interrupted by the War, would have had a place in the first rank of the priority list. Yet here is the Science Museum, which is charged with the duty of affording public illustration and visual exposition of the great current advances in the physical sciences and in the applications of science to industry, practically obstructed in all new work by lack of space. The functions of the museum are so closely related to important national interests that its equipment has become a matter of urgency, and the facts summarised in our article on the subject suffice to show the need for an emphatic appeal that the continuance of the work on its building should have an assured place in the programme of new national buildings.

The building now in progress is the outcome of action taken in pursuance of representations made to the Board of Education in 1909 by a deputation and a memorial from those prominently interested in the advancement of pure and applied science. In presenting the memorial, Sir Henry Roscoe quoted from the 1874 report of the Duke of Devonshire's Commission on Science, strongly recommending the establishment of a museum representative of all branches of physical science, both pure and applied. He and those with him in the deputation then emphasised the necessity for proper housing for such a museum, and the advantages of properly housed collections. They pointed out, too, that without adequate accommodation the Museum could not benefit as it otherwise would by gifts of many objects of interest which have high value for museum collections.

The fact is that, in the matter of buildings, this museum has lagged far behind the museums that represent other branches of knowledge and of culture. One may well ask how this has come about. The answer is largely one of history. The Science Museum is the youngest of our national museums: for although science collections were first prepared for museum exhibition in 1857, it was not until twenty years later that the real possibilities of such collections began to be widely recognised. The earlier collections were formed with the view of following up in particular directions the impulse which the Exhibition of 1851 had given to public interest in science and industry. At that time the larger groups of objects came under the following headings: Foods, animal products of industrial value, building structure and materials, models of machinery and educational apparatus. It was the Fourth Report (1874) of the Royal Commission on Scientific Instruction and the Advancement of Science that directed attention to the wide field of usefulness that was open to well-devised science collections; and it was the demonstration afforded by the great loan collection of scientific apparatus, formed at South Kensington in 1876, that proved the turning-point in the aims of the museum collections. Many of the objects lent for that temporary collection became the property of the nation and formed the nucleus of the collections of to-day. It is right to note here that the advance then made in the museum ideal owed much indeed to the initiative and to the indefatigable labours of the late Sir Norman Lockyer, who was secretary to the Commission.

Almost concurrent with the wider conception of the relation of the Museum to pure science came the recognition of the importance of preserving and exhibiting actual examples of great inventions. The many-sided appeals of such objects had led Mr. Bennet Woodcroft to form a collection that was, and must always be, unique, and the transference of his collection to the Department of Science and Art in 1883 laid the foundation of the fine collection which now illustrates machinery and the history of invention.

Successive committees have reported on various aspects of the uses and needs of the Science Museum. Their reports in 1886, 1889, 1897, 1898, and 1900 form a long chain of scientific and technical opinion. These, however, failed to secure the full measure of official backing and of national support which they well merited. Yet in their estimates of needs they were most modest—perhaps *too* modest. Men of science accustomed to work in laboratories providing only the bare necessaries for their investigations, failed to realise that the great museum-visiting public needs space in which to move about freely, and requires the exhibition of objects rather than a mere opportunity of examining them under difficulties. Be that as it may, in accordance with scientific habit they limited their recommendations, in matter and in measure, to needs which could be proved up to the hilt; but people accustomed to the evaluation of reports in other interests—reports made, it may be, with greater imagination and longer views—had acquired a habit of making a large discount from the claims made in commission reports generally.

Since the new departure in the early 'eighties the Science Collections, alike in pure and in applied science, have had many acquisitions of great and abiding interest, and the methods of displaying these have developed steadily. The aim of the Museum has been to do all that considered preparation of objects and appropriate methods of exhibition can do to enable scientific instruments, machinery, models, etc., to speak for themselves. By exhibited objects, it affords telling illustration and exposition pertaining to the various branches of science within its field and of their applications in the arts and industries. It also preserves appliances which hold honoured places in the progress of science or in the history of invention, and with such exhibits it associates the names of the great men to whom the world owes these successive advances. This human element in the interests which the Science Collections present accounts for no small part of the crowds who visit the galleries at times when any large section of the public is free from work. The exhibited machines, or other inventions which have created or revolutionised industries and have altered conditions of life, arouse in even the most casual of visitors something more than admiration for the genius and skill of the inventor. Such objects as those illustrating early steam-engines, telegraphs and telephones, or the successive stages of the development of ships, never fail to appeal to popular intelligence and imagination. Indeed, many of the treasures of the Science Museum are irreplaceable in respect of value for the intellectual inspiration of the people.

For the use of the Museum by the general public, larger space for exhibition and more ample gangways for the circulation of visitors are the most pressing needs; but a suitable setting for the collections, and a worthy front and entrance to the building, are essential to the recognition of the real value of the Museum as a factor in the intellectual machinery of the nation. Students and investigators who use the Museum need all these; but they need more. The report of Sir Hugh Bell's committee sets out the directions in which material facilities are required for the critical examination of instruments, or for public or private exposition of objects, but until an adequate building is provided for the Museum collections these uses are seriously limited; thus individuals and institutions interested in physical and applied science must wait for some years yet before they can enjoy the wider uses pointed out in the committee's report.

The deputation to the president of the Board of Education in 1909 pointed out that by far the largest part of the Science Collections come as gifts or loans, so that if an adequate and worthy building were provided, it need not be anticipated that the annual subsidy for purchases would be on the high scale required for the other great national museums and galleries. The maintenance vote is also relatively small, and the capital expenditure required for the building is not even now deterrent. It is not too much to expect that in these circumstances the work on the buildings will be pushed forward vigorously and without break.

Meteorological Physics.

The Air and its Ways: the Rede Lecture (1921) in the University of Cambridge, with other Contributions to Meteorology for Schools and Colleges. By Sir Napier Shaw. Pp. xx+237+28 plates. (Cambridge: at the University Press, 1923.) 30*s*. net.

IN this volume Sir Napier Shaw has collected fifteen different lectures and papers upon a variety of different subjects, to a few only of which we can here refer. Throughout the whole book is a number of leading ideas, for which the author has been an indefatigable and mostly also a successful advocate, to the benefit of meteorological science.

The first point which strikes the reader when he opens the book is twenty-four plates representing the normal distribution of the meteorological elements over the globe. Several of these charts are new from the author's hand. By placing these charts at the beginning of the book, and by returning to them incessantly in discussing the special questions in the subsequent papers, the author has succeeded in emphasising strongly his view of "the weather of any locality as part of the weather of the world." Statistics can be made for a single locality. Atmospheric events, on the contrary, can never be understood from local, but only from universal points of view.

To understand the phenomena of the weather means, according to Sir Napier Shaw, "to bring our knowledge of the air into relation with the laws of physics, as established in the laboratory, and therefore particularly with the law of energy." We meet with this view already in the charmingly written first lecture, "Meteorology for Schools and Colleges," and it follows us all through the book to the last lecture on "The Artificial Control of the Weather." An important consequence of this view of meteorology as applied physics forms the subject of the second lecture on "Pressure in Absolute Units."

Among the leading ideas of a more special meteorological nature the author emphasises in the preface three as especially important—those of "balanced forces," of "eviction," and of "resilience." In his discussions of meteorological phenomena these principles recur repeatedly. We meet with an example of the application of the principle of resilience on the first page of the first lecture, when we read this characteristic remark concerning the conditions for the formation of orographic rainfall: "But when you come to think of it, the explanation requires that the air on the windward side has to be made to flow up-hill, and no fluid which technically must be called heavy, as it is affected by gravity, even if it is as light as air, flows up-hill without protest. It prefers to go round, and will exhaust all the possibilities of doing so before submitting to be driven over." This principle of resilience should be remembered not least by mathematicians who will work out the theory of atmospheric movements. In theoretical hydrodynamics we generally assume the equation $s=f(p)$, density as a function of the pressure. This equation leads to that state of "unlimited miscibility" which excludes resilience and would make it possible for the air to flow up-hill without protest. But the true equation $s=f(p, \theta)$ permits the air to take a stable stratification, a permission of which it makes a most extensive use; with the consequence that we have laws of motion very different from those of the idealised fluid, in which $s=f(p)$. I can scarcely be wrong when I say that this equation has for more than a century acted as a barrier which has prevented the representatives of theoretical hydrodynamics from taking up meteorological problems with success.

The principle of "balanced forces" merits great attention, not only in qualitative discussions but also perhaps still more by the attempts to work out mathematical theories of atmospheric motions. The author gives no mathematical formulation of the principle. But if I have understood him rightly, I should call it rather very good advice than a principle. The most obvious way of developing atmospheric movements might seem to be this: first to consider the state of equilibrium, and then to examine the consequences of a disturbance of it, in the case before us of a disturbance of thermal origin. But on account of the rotation of the earth there is a very long and difficult way from the state of equilibrium relative to the earth to the ultimately resulting motion. The primary tendency is the production of a direct flow from the cold to the warm areas. But this tendency is almost completely checked by the effect of the earth's rotation. Instead of the direct flow from cold to warm areas, we get a circulation cyclonic round the warm and anticyclonic round the cold areas. Only a small residual leakage is left, conveying very gradually air from the cold to the warm areas. For this leakage the process of "eviction" plays an important part.

Now Sir Napier Shaw's advice is to shorten this long development, which it is very difficult to give in a satisfactory form, and to start with that state of steady motion relative to the earth which is characterised by the "gradient wind." This gradient wind, by which pressure gradient and deflecting force balance each other, gives immediately the cyclonic circulation round the warm areas and the anticyclonic circulation round the cold. Then, in the second approximation, we have to add to this pure circulation the further disturbances, as those connected with convection and that particular form of convection for which Sir Napier Shaw has introduced the word eviction. No doubt his advice will be followed more and more, both in elementary treatises and especially in mathematical theories, for which this may prove to be the only practicable way.

I cannot finish this notice without mentioning Sir Napier Shaw's brilliant style of writing, the many adequate expressions and striking comparisons by which he succeeds in making the subject clear and ensures that the reader does not forget the main points. He is a master of finding the right words, and is not less a master of illustrating the text by characteristic diagrams. I only regret that he has not found place in the book for that really historical diagram by which he formulated his protest against the old cyclone theory and gave the main structure of the new one, replacing the fine logarithmic spirals running asymptotically to a centre in the old model simply by three sets of straight lines, of which two sets meet each other at right angles. V. BJERKNES.

Philosophy for Men of Science.

Scientific Thought. By Prof. C. D. Broad. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. 555. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1923.) 16s. net.

As men of science are usually impatient, if not contemptuous, of philosophical discussion, Prof. Broad may be thought rash to address a philosophical work specifically to them, particularly as he is occupied in discussing the notions of space, time, matter, and motion, about which the man in the laboratory considers himself better qualified to speak than the philosopher. The author, however, brings to his task both a knowledge of mathematics and physics and an appreciation of the efforts of philosophers in the "peculiarly obstinate attempt to think clearly," which constitutes their chief task. Moreover, unlike many philosophers and men of science, he expresses himself clearly, so that any one who reads his book will discover at least one philosopher who does not "tell us what every one knows in language that no one can understand."

Part 1 consists of an analysis of the conceptions of space and time in modern physics and leads up to an account of the special and general theories of relativity. This has all been done before, but not quite in the same way. The author starts at the beginning, or what ought to be the beginning of any such discussion, by giving a simple account of Prof. A. N. Whitehead's "Principle of Extensive Abstraction." This principle provides a rational method of passing from the actual facts of sense-experience to the highly sophisticated conceptions, such as points and lines, that are necessary for geometry and mathematical physics, and is indispensable for any proper theory of space and time. Prof. Broad's exposition provides a good introduction to Prof. Whitehead's own decidedly difficult works. In the second chapter on time and change, with Prof. Whitehead's treatment of time as a basis, some valuable and original ideas are developed. This chapter is perhaps the most important in the whole book. The rest of Part 1 follows well-established lines and does not call for special comment, except in so far as it gives a clear account of a difficult subject.

In Part 2 the author takes up his problem from a different point of view, that of the relation of the physical theory of material bodies to the facts of sense-experience. Here Prof. Broad is for the most part breaking new ground, and for that reason alone his argument is rather more difficult to follow. Moreover, he is now dealing with problems which do not appeal greatly to the man of science, who may refuse to recognise them as problems at all. He will probably assent vaguely to the saying of Petronius standing at the head of chapter 7:

> Fallunt nos oculi, vagique sensus
> Oppressa ratione mentiuntur.

The man of science may even confess that the ridiculous theory of pp. 272 and 273 is not an unfair summary of his own and his friends' views as to the nature of physical objects and their sensible appearances, but still he may be inclined to say, "Why make all this fuss about it? I know it is easy for a philosopher, with his puzzles about pennies that are 'really' round, though they 'look' elliptical, and about mirror images, and so on, to pick holes in the ordinary common-sense and scientific notion of material objects, but what does it all come to? The ordinary theory, however silly ultimately, is simple and familiar and works well in practice. The philosophical theories are not simple, there are several different ones, and there is nothing to show that they are better for ordinary purposes."

Prof. Broad has not played his cards very well in order to refute such contentions as this and induce the man of science to read on, for he has kept his best arguments for his last chapter. The argument is, briefly, that the ordinary view only works in practice by leaving out the facts that do not fit in with it. It so happens that these inconvenient facts have not, up to the present time, been important and that the man of science has been well advised to forget them and get on with his work, but this happy state of affairs may not last for ever. The history of the theory of space and time supplies the moral. The traditional theory was simple and easy to understand and worked well; the engineer and the chemist still ask for nothing better. It has only been gradually that the incompatible facts have been forced on people's attention in spite of struggles to ignore them; and some people still ask, "Why all this fuss about the principle of relativity?" The only answer is that clear ideas, if we can get them, are better than muddled ones, however comfortable. What is worth doing for space and time is also worth attempting for sense perception and material objects.

It is impossible in the course of a short notice to make any detailed criticisms of this latter part of the book; suffice to say it is the kind of thing scientific philosophers ought to write and philosophical men of science to read.

The author shows wit and erudition in his chapter headings, though he might have translated King Alfred for us. The index is full and carefully compiled. As the author shows some pedantry in the matter of authors' names and titles, it is not unfair to point out that Galileo is a Christian name, consequently there was no such person as "Galileo, G." A. D. R.

Geology in War.

(1) *The Work of the Royal Engineers in the European War, 1914–19. Work in the Field under the Engineer-in-Chief, B.E.F. Geological Work on the Western Front.* Pp. 71 + 7 plates + 19 figs. (Chatham: W. and J. Mackay and Co., Ltd., 1922.)

(2) *The Work of the Royal Engineers in the European War, 1914–19. Work in the Field in other Theatres of War. Egypt and Palestine—Water Supply.* Pp. vi + 64 + 7 maps + 10 plates. (Chatham: W. and J. Mackay and Co., Ltd., 1921.)

IN 1914 there was no geological organisation in the British Army, though it would appear that the Germans had a definite geological establishment in connexion with each of their Armies. Very early during the War the need of geological advice was felt in connexion with the supply of water to the troops both in the battle zone and on the lines of communication, but it was not until April 1915 that a geologist was appointed, and not until the following June that he joined the staff of the Chief Engineer in France. In 1916 Lieut.-Col. Sir T. W. Edgeworth David joined the staff and eventually became Geological Adviser at G.H.Q. on matters connected with military mining. Now a permanent geological establishment is suggested.

The volume under review gives a concise account of the work carried out by the geological staff on the Western Front and is copiously illustrated by maps, sections, and photographs. The chief method of supply of water was from borings in the Upper Chalk (Senonian), and though in many cases the sites for bores were chosen for military rather than geological considerations, the maps showing the possibilities of obtaining a supply in different parts of the area were invaluable to the Army Water Supply officers. Water was also obtained from the Thanet Sands, and the various kinds of apparatus employed in boring and pumping are described in detail.

An investigation of the water-table in the Chalk was made in connexion with water supply, and the fluctuations of level were studied for the purposes of military mining and the construction of dug-outs. The importance of a thorough knowledge of geological structure in connexion with the construction of military mines is demonstrated, and details are given of several series the success of which depended on such knowledge.

Other military activities requiring the services of the geologist were the winning of road-metal, the provision of sand and aggregate for concrete, and the working of such coal mines as remained in the hands of the Allies.

The plates include a map showing by colour-washes the suitability of the country for dug-outs and others indicating the ancient excavations ("Souterrains"), which were so largely used as cover for troops in Northern France.

The second volume under notice contains an interesting account of the enormous difficulties successfully overcome by the Royal Engineers in the supply of water to the army during its advance across the Desert of Sinai from Egypt into Palestine.

The work included the laying of a pipe-line, by means of which a daily supply of 600,000 gallons of Nile water was carried to the troops in El Arish, and along the lines of communication; the transport of water in railway tanks and on camels; the development of local supplies in Beersheba and Ghaza and in the plains of Palestine, and finally the reorganisation of the water supply of Jerusalem itself.

The Antiquity of Disease.

The Antiquity of Disease. By Prof. Roy L. Moodie. (University of Chicago Science Series.) Pp. xiv + 148. (Chicago: University of Chicago Press; London: Cambridge University Press, 1923.) 1.50 dollars.

Studies in the Palæopathology of Egypt. By Sir Marc Armand Ruffer. Edited by Prof. R. L. Moodie. Pp. xx + 372 + 71 plates. (Chicago: The University of Chicago Press; London: Cambridge University Press, 1921.) 17*s*. net.

AT a time when those concerned with medical education are concentrating their endeavours as never before upon the problems of the causes and prevention of disease, a book that attempts to probe into the distant past and discover the early history of pathological processes is sure of a welcome, even if the subject is described by the wholly unnecessary and ambiguous word "palæopathology." The chief value of Prof. Roy Moodie's fascinating and well-illustrated little book is that it directs attention to the scope and interest of such studies and provides a bibliography extensive enough to start the inquirer on his way to enlightenment. The pathological conditions revealed in fossil vertebrates, and the identification of the destruction wrought in fossil bones by contemporary bacteria and fungi, prepare us to accept the evidence that bodies resembling bacteria and cocci in fossils as old as the Palæozoic are actually fossilised micro-organisms.

The part played by bacteria in remotely ancient times is as yet only a subject for speculation. "The pre-Cambrian bacteria so far known are supposed to have had an activity allied to that described by Drew for *Bacterium calcis* and other marine calcium-precipitating bacteria." "The results of infection by bacteria are not definitely known prior to the Permian. Bacteria and fungi, possibly, however, chiefly those of decay, are widely distributed and well known from the Carboniferous rocks. Here lies a wide field of research, although a difficult one, dealing with the origin of that type of disease which is so troublesome to humanity to-day. It seems probable from present evidences that a wide distribution of the bacterial types of disease and the resulting pathology is a relatively recent phenomenon, with an antiquity of a few million years, which, when compared with the scores of millions, possibly hundreds of millions, of years which animal and plant life have existed, is a very brief time" (pp. 13 and 14).

The earlier part of the book, which deals with these interesting problems of palæontology, is very suggestive and stimulating. The latter part, dealing with early man, makes a more immediate and personal appeal and is distinguished by the same qualities of suggestiveness;

but unfortunately its accuracy cannot be trusted. The author commits many mistakes which are scarcely excusable on the part of the editor of the late Sir Armand Ruffer's works. It is natural that he should feel a deep sense of gratitude to the genial scholar whose writings directed his attention to the study of the effects of disease in ancient man; but the works of Sir Armand Ruffer give no warrant for the many misleading statements in the final chapter of this book. Hence it becomes necessary to warn readers of this chapter not to accept its statements as facts until they have been checked by reference to the standard work on the pathological conditions found in ancient Egyptian bodies, Prof. Wood Jones's statement in the Report for 1907–08 of the Archæological Survey of Nubia. It is particularly necessary to correct Prof. Moodie's misleading references to syphilis (p. 117), smallpox (p. 119), pyorrhœa (p. 126), and Pott's disease, which he says is "so common in Egypt" (p. 133), when I think he was aware of only *one* case (or at most six cases) found among thirty thousand bodies!

I refer to these blots on a very fascinating and stimulating book before such insidious errors get fully launched upon a career of diffusion. In several places in the book Prof. Moodie refers to the history of these modern investigations in the pathology of the ancient Egyptians, and as his account is quite fictitious, perhaps I might explain how they did begin. Two months after my arrival in Egypt in 1900 the late Dr. W. H. R. Rivers, who was working on the problems of colour vision in the natives of Upper Egypt, wrote directing my attention to the natural preservation of the brain in the Pre-dynastic bodies being excavated by Dr. Randall-MacIver at El Amrah. I went to Upper Egypt to study this remarkable phenomenon, and the first ancient Egyptian grave I looked into contained the skeleton of a boy who lived nearly sixty centuries ago and had suffered from stone in the bladder. I sent the specimen to Dr. Shattock at the Royal College of Surgeons, who published a report on it, and for the next seven years I devoted much of my leisure to the collection of pathological specimens from ancient graves until, in 1907, Dr. Wood Jones began his epoch-making work of making the collection now in the Museum of the Royal College of Surgeons, and writing the only trustworthy account of the pathological conditions found in Egypt and Nubia that has yet been published.

The late Sir Armand Ruffer did not begin his work until Prof. Wood Jones and I had completed ours. In 1908, having discovered a hunch-back among the mummies of the priests of Amen from Thebes, I asked the late Profs. Ferguson and Ruffer whether they could detect tubercle bacilli in his psoas abscess. This started Sir Armand on the work. In attempting to put the history of these events into their proper sequence I ought to direct attention to the real achievements of the late Sir Armand Ruffer in this field. These were, first, the perfection of the technique for the histological study of mummies; and, secondly, the discovery of the eggs of the Bilharzia worm in mummies embalmed thirty centuries ago. These results were attained only after long and wearisome experiment carried on with exceptional skill and persistence, and represent a very great achievement.

G. Elliot Smith.

Our Bookshelf.

Factors affecting the Control of the Tea Mosquito Bug (Helopeltis theivora, *Waterh.*). By E. A. Andrews. Pp. iv + 260 + 44 diagrams. (London: Indian Tea Association, 21 Mincing Lane, 1923.) 3*s*. 6*d*.

The work which Mr. E. A. Andrews has carried out in India in connexion with the mosquito bug of tea is described in this book. The limitations in the control of the pest by spraying are discussed, and an inquiry into the question of natural checks has led to the conclusion that the problem could not be solved by such means. The effects of climate and the variety of bush which is cultivated are discussed in some detail.

The action of various manures has been investigated, lime and potash manures having been shown to be of benefit. The relation of cultural operations to the severity of attack is also included. Whereas no relation is evident between the total quantities of potash and phosphoric acid present in the soil and the extent of attack, manuring experiments have yielded interesting and definite results. Immunity would seem to depend on the ratio of the available potash to the available phosphoric acid. Great benefit is derived from an increase in the available potash in the soil, the effect, however, being only transient. Analyses of the leaves show differences corresponding to those deduced from observation of the soils. Immunity has been induced experimentally by the direct introduction of potash to the plant, tea bushes so treated remaining immune for the rest of the season.

The importance of this work from an economic point of view is very great. The future of economic applied entomology lies far more in the detailed study of the relations between the insect, the plant, and the natural conditions influencing both, than in direct control by means of insecticides or entomological methods: such research, however, requires organised team work between the various branches of science. Mr. Andrews's work would be valuable if it emphasised this need alone; but it also embraces sound investigation and a great hope of the discovery of a practical control for the most serious insect pest of the tea crop.

The author is to be congratulated on his results and the patience with which he has collected his numerous data.

H. M. L.

Agriculture in the Tropics: An Elementary Treatise. By Dr. J. C. Willis. (Cambridge Biological Series.) Third edition, revised. Pp. xvi+223+24 plates. (Cambridge: At the University Press, 1922.) 12s. 6d. net.

DR. WILLIS's book was intended, not as a practical guide in field methods for the tropical agriculturist, but to serve mainly as an introduction to the study of the leading economic principles governing the modern practice of agriculture and planting in the tropics. With the remarkable developments taking place in tropical agriculture, such a book will require periodical revision to keep abreast of the times. The second edition was published in 1914, and the call for the present (third) issue has afforded a further opportunity for revision. It is a pity that no preface to the new edition has been printed, and, except for special information supplied by the publishers for the convenience of the reviewer, it would be difficult to trace new matter or corrections.

No important re-arrangement of the book has been adopted. The four parts remain the same and the slight revisions made in them are neither numerous nor very important. There are still opportunities, however, for improvement in the text. In dealing with the West African oil-palm (*Elæis guineensis*) due reference is made to the recent planting of the palm in the East, but the student would gather very little as to the origin of the "pericarp" oil (not mentioned as such) from the account given; while the statement that "of late another oil has been obtained from the seeds of the palm" is a little naïve. Definite reference also should be made to the wide use of coco-nut oil for the manufacture of margarine. Further, as regards gingelly oil, while it may be true that comparatively little of the oil is exported from the countries of production, the statement should be completed by reference to the important export of the seed for oil extraction in Europe.

The book remains, however, an excellent introduction to a subject of great and increasing importance, and should be read by all interested in the practice and administration of tropical agriculture and planting.

Crystallisation of Metals: being a Course of Advanced Lectures in Metallurgy delivered at the Royal School of Mines, Imperial College, under the Auspices of the University of London, in February and March 1922. By Col. N. T. Belaiew. Pp. 143+21 plates. (London: University of London Press, Ltd., n.d.) 7s. 6d. net.

COLONEL BELAIEW has written a book on the "Crystallisation of Metals," which is remarkable in that it deals with the coarse structure rather than the microstructure of metals. It is therefore noteworthy that a great many of his illustrations are natural size, while others are ×2, 5, or 10. Only in rare instances are higher magnifications used, although in certain extreme cases remarkable pictures are given in which the magnification is as high as 4500. At the other extreme, two illustrations are given on a *reduced* scale (×⅓) of Tschernoff's famous crystal, more than fifteen inches in length, which was found in the upper portion of the pipe in the sinking head of an ingot of soft open-hearth steel weighing about 100 tons. The final paragraphs of the book deal with the structure of Damascene steel, and include two beautiful illustrations, of approximately natural size, of Damascene blades, as well as microphotographs with an enlargement of 1000 diameters. The little book forms an admirable supplement to existing treatises on metallography, and reaches a level which entitles it to a place among standard works on this subject.

Visual Illusions: their Causes, Characteristics, and Applications. By M. Luckiesh. Pp. ix+252. (London, Bombay, and Sydney: Constable and Co., Ltd., 1922.) 15s. net.

IN this book Mr. Luckiesh presents one hundred illustrations of familiar and little-known optical illusions, round which the text is written. On account of the great complexity of the subject, the author confines himself to static illusions, and dispenses to a large extent with theory. It is inevitable that there should be some overlapping in any classification of visual illusions, since not seldom more than one factor enters into them; but the arrangement or grouping together in the various chapters which is adopted in the book is a convenient and practical one. After chapters on the eye and vision, geometrical and depth, or distance, illusions are considered in detail. These are followed by illusions due to irradiation, colour, and lighting. A special chapter is added on natural illusions, such as the apparent size of the setting sun as compared with the sun at the zenith, the magnification of objects seen through fog, and mirage. The last four chapters are devoted to applications of the natural principles of visual illusions to practical purposes, in the shape of painting, decoration, architecture, and camouflage. The book is well written and attractively produced, and should be of interest to others as well as to students of psychology.

Geology. By C. I. Gardiner. (Science for All Series.) Pp. x+138. (London: J. Murray, 1923.) 3s. 6d.

IN 1914, Mr. Gardiner produced his "Introduction to Geology" (see NATURE, vol. 94, p. 362), in which he found more scope for originality than is given by this smaller volume. The conception of a work on geology "for all" must vary with the outlook of the author, and Mr. Gardiner has had long experience in the training of beginners in the region where the foundations of stratigraphical geology were laid within the British Isles. We cannot help thinking that "all" would like to hear something of the Laurentian cauldrons in which the oldest strata of Canada were immersed; of the rich fauna of the Olenellus-beds; of the coming of the race of reptiles that was so long to dominate the world; and of the amazing development of mammals, from South Dakota and the Paris Basin to the Trinil river-bank in Java. But Mr. Gardiner knows well that a fossil picked up in a Gloucestershire lane or from a talus in the Isle of Wight may loom more largely than Atlantosaurus or the titanotheres. All reputable English text-books insist upon the Woolhope Limestone and the Thanet Sands. That we cannot escape from them in so small a volume is no sign of Mr. Gardiner's personal limitations. His style is always clear, and throughout he is in touch with recent observations.

G. A. J. C.

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.*]

The Mechanical Equivalent of Heat.

WITH the assistance first of Dr. J. K. Roberts, now of the National Physical Laboratory, and later of Mr. E. O. Hercus, I have been engaged for some years upon a determination of the mechanical equivalent of heat. It is believed that an indication of the lines upon which the experiment is being made may be of use to other workers in this branch of physics.

A number of determinations of what may be called the electrical equivalent of heat have been made, including the very thorough work of Jaeger and Steinwehr at the Reichsanstalt, but since the time of Joule the only direct measurements of the mechanical equivalent of heat are those of Rowland published in 1880 and of Reynolds and Moorby. The work of the former has for long been regarded as of high accuracy. Reynolds and Moorby's result is in terms of the mean calorie, and there is considerable room for doubt as to the value of that calorie in terms of the 15° or the 20° calorie. This doubt arises from the conflicting values found for the specific heat of water from, say, 60° to 100° C. It appeared, then, to be desirable to have a direct determination of the mechanical equivalent of sufficient accuracy as to be available for comparison with the electrical equivalent of heat. Such a comparison may throw light on the absolute values of the electrical units. It must be admitted, however, that to obtain the necessary accuracy in the value of the mechanical equivalent for that purpose will be a problem of some difficulty. But there appears to be no reason, if the same attention is given to the question as has been given to the realisation of the electrical units, why it should not be attained.

In our experiment, work is indirectly converted into heat; the work done and the heat developed are directly measured. The work is found, as in Rowland's experiment, in terms of a couple and a number of revolutions; the heat is measured by a continuous flow calorimeter in terms of a quantity of water and its rise of temperature. A correction is made for the heat lost during an experiment. The relation between these quantities is

$$2\pi nmgd = Jw(t_2 - t_1) + L$$

where J ergs per calorie is the mechanical equivalent of heat. The apparatus is designed so that the heat lost can either be directly determined, or be eliminated by taking the difference between the equations for a heavy and a light run.

The efficiency of an apparatus for finding the electrical or the mechanical equivalent of heat, which may be briefly called a J apparatus, is expressed by two characteristics, namely, (1) the percentage of the heat developed which is lost, and (2) the accuracy with which the lost heat can be determined, or eliminated from the expression for J.

We have gradually developed, after many failures, an apparatus which, measured by this test, is an efficient one. We set out in the following table average figures for the power absorbed, and the percentage of heat lost in experiments by the observers named:

Observer.	Power.	Percentage of Heat lost.
Rowland	0·4 H.P.	3
Callendar and Barnes .	0·03 ,,	2
Reynolds and Moorby .	70 ,,	0·8
Laby and Hercus . .	0·2 ,,	about 0·2

Any apparatus for the direct determination of J is a brake dynamometer. Reynolds and Moorby, for example, used the Froude hydraulic brake, which is the same in principle as the devices used by Joule and by Rowland, but the design is more efficient. We

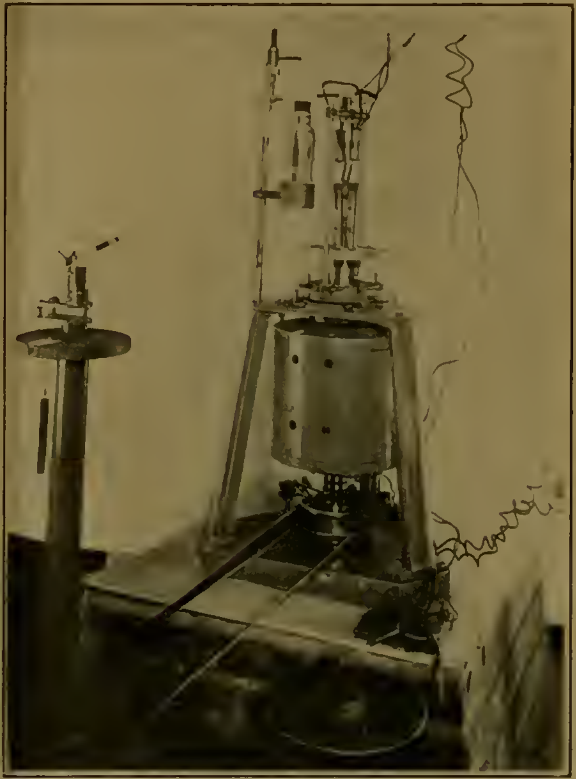


FIG. 1.

decided to enclose the brake in a vacuum flask, in order to obtain high thermal insulation, and to use continuous flow calorimetry. The brake we are using is an electro-magnetic induction brake, which is closely analogous to an induction motor. The construction of the brake is shown in Figs. 1 and 2. An electromagnet (see Fig. 2) rotates about a vertical axis; in the rotating magnetic field so produced a copper cylinder (Fig. 2) and an iron core are placed. The copper and iron cylinders are attached by means of a glass tube to the inner sleeve of a bearing. This part of the apparatus is called the stator. The rotating magnetic field induces eddy currents in the copper cylinder, which is thereby heated, and the reaction between these currents and the rotating field causes a couple to act on the stator.

The couple acting on the stator is balanced by the tensions in two wires attached to the torsion wheel carrying two weights, one of which is shown at the left of Fig. 1. The only details which need be mentioned of this part of the apparatus are the devices used to reduce friction. The bearing (Fig. 2) is a parallel ball-bearing for which the friction is less than 1/10,000 of the couple acting on the stator. To eliminate friction, the wheels over which the above-mentioned wires pass are carried on steel knife-edges resting on hardened steel planes.

For the temperature measurements we use platinum thermometers which are connected differentially to a Wheatstone bridge made to Müller's design. During the course of a year the average variation of the fundamental interval from its mean value has been 1/20,000 for one thermometer and 1/80,000 for the other. This would imply that the thermometry is of satisfactory accuracy.

The evaluation of the heat lost has proved far the most difficult part of the experiment.

In the earlier designs the loss in some experiments

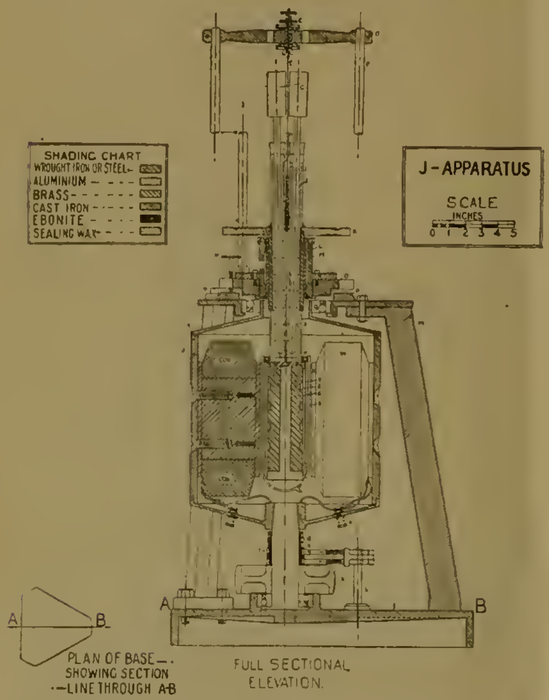


FIG. 2.

was as high as 2 per cent of the heat developed. All attempts to determine it correctly, or to eliminate it by taking the difference between a heavy and a light experiment failed, for reasons which cannot be given here. To overcome this difficulty the calorimeter system was reconstructed, by bringing the thermometers close to the vacuum flask and highly insulating them, as shown in the accompanying figures. This has reduced the heat loss to about 1/10 of its previous value. Means have been provided for determining the loss, and the stator is being modified so that the loss may be eliminated in the usual manner in continuous flow calorimetry by taking the difference between a heavy and a light experiment. It is expected that this alteration will increase the heat developed, and so reduce the percentage of heat lost still further.

T. H. LABY.

University of Melbourne, April 4.

The Transformation of Electronic into Electro-Magnetic Energy.

THE fundamental propositions given below, which do not refer to the excitation of characteristic but to that of the ordinary rays which have been called "independent" X-rays, have sufficient experimental evidence supporting them to justify the following statements so that they may serve as guiding principles for further investigations.

1. When a definite number of electrons in motion (cathode or β-particles) of definite velocity traverse very thin layers of different substances, the average fraction of their energy transformed into that of electromagnetic radiation (X- or γ-rays) is, per atom of any one substance, proportional to the square of its atomic number.

2. In these circumstances, for a given layer, the energy so transformed depends only on the mass per unit area of the layer and on the number of cathode or β-particles traversing it, being independent of their velocity.

By a very thin layer is meant one so thin that the ratio of the number of particles emerging from the layer to the number entering it is very nearly equal to unity.

The reason for the above statement is as follows. If cathode or β-particles of definite type and of total energy E traverse a layer of a substance of unit area and mass dm, the energy of the X-rays formed in the layer may be written as $\lambda E.dm$. We call λ the mass transformation coefficient. The atomic transformation coefficient, α say, is then obtained by multiplying λ by A/N, where A is the atomic weight and N is the number of atoms in a gram of hydrogen. I find that α, which gives the average fraction of the energy transformed per atom, varies approximately as the square of the atomic number Z, while λ varies as Z^2/A and both α and λ vary inversely as the energy of a single bombarding particle. Hence the above propositions hold approximately, since the total energy E is proportional to the energy of a single particle and their number n, so that $\lambda E.dm$ varies as $n.dm$.

With respect to the physical processes underlying the excitation of "independent" X-rays, certain considerations incline me to the provisional view that these X-rays are produced by a collision or by close interaction between the cathode or β-particles and the actual nuclei of the atoms rather than with the electrons surrounding them.

J. A. GRAY.

McGill University, Montreal,
May 21.

Dr. Kammerer's Alytes.

PROF. MACBRIDE's letter in NATURE of June 23, p. 841, did not at first seem to require any rejoinder. But I find that some botanists, and perhaps others unfamiliar with zoological terms, suppose that the quotations from Boulenger contradict my statement that rugosities are not formed on the palmar surfaces. Boulenger, of course with perfect accuracy, states that rugosities in various genera appear on the *inner* side of the digits (italicised by Prof. MacBride). This is the *radial* side, as emphasised in both our letters, not the palmar surface, which was the part which bore the extraordinary structure visible in Dr. Kammerer's specimen.

W. BATESON.

June 24.

The Breeding Period of *Echinus miliaris*.

THE breeding period of the sea-urchin, *Echinus miliaris*, is very interesting from many points of view; and especially as this animal readily yields ripe eggs and sperm with which to carry out artificial fertilisation in inland laboratories for the observation of fertilisation, segmentation and gastrulation stages in the living state. The records made at this laboratory down to 1919 showed that *E. miliaris* has been found to breed from about February-March to August. In 1920 I arrived at the conclusion that certain marine animals, such as the oyster, breed continuously so long as the sea-temperature remains above a definite temperature, providing the general biological conditions are otherwise normal. On this view, and if the type of breeding in *E. miliaris* were the same as that of the oyster, the breeding period of this sea-urchin should be found to extend to about November-December, on the average.

In March and April 1920 many successful artificial fertilisations of *E. miliaris* were made, and it may be assumed that similar successful fertilisations could have been obtained onwards to August. After August periodical collections of this urchin were made *from the shore* to test the view mentioned above. On September 14 the proportion of ripe individuals collected was high and six excellent artificial fertilisations made; on October 13 the proportion of ripe individuals collected was smaller, but good fertilisations were still obtained, and on October 29, although the proportion of ripe individuals was now lower, an optimum fertilisation was obtained yielding very fine and healthy plutei on November 1. The observations at Plymouth were interrupted at this time, but on November 3 a high proportion of *E. miliaris* which had been *dredged* from the oyster beds off Whitstable were found to be ripe and yielded healthy larvæ, which lived in some bowls as plutei until at least January 5, 1921. A batch of similar urchins forwarded to Plymouth yielded an excellent fertilisation on November 10,[1] and although no fertilisation was made later, it was observed at various times during the winter that the gonads of Whitstable specimens examined remained full. A sample of urchins examined at Plymouth on January 26, 1921, showed that a small proportion of ripe males with full gonads still occurred but no ripe female was found, and the big variation in size of the gonad observed in the remainder of this sample points to a distinct physiological difference between the Plymouth and Whitstable groups.

It is thus clear that successful artificial fertilisations of *E. miliaris* may be obtained from Plymouth specimens during about the period February-March to November, and that the breeding period in the south of England may be considered to extend over the same range, but it is nevertheless open to doubt whether the capacity to yield a successful fertilisation may be good evidence that a species is breeding.

The fact that breeding individuals may be obtained over such a long period of the year affords good reason to believe that single individuals may spawn several times a year, but there is no evidence that collective spawning occurs in this species at one given phase of the lunar cycle such as Fox found to be the case in the Mediterranean sea-urchin *Diadema setasum* (see NATURE, February 23, 1922). In three collections of *E. miliaris* from Looe Is. near Plymouth, on September 23, October 12, and October 28 respectively, the unripe individuals showed variation in the size of the gonad ranging from about 1/12 to a full gonad. These observations do not, however, rule out the possibility of spawning occurring normally—in those individuals which are ripe—at certain definite phases of the lunar cycle, for example, after any low-water springs; for it has been observed not infrequently that ripe specimens collected at low-water spawn before arriving at the laboratory.

The sex-conditions in the collection of *E. miliaris* mentioned above were examined closely for any appearances indicating sex-change; for a condition of sex-change in sea-urchins may be regarded as a possibility in view of Mortensen's discovery of the common occurrence of protandric hermaphroditism in ophiuroids and of Fox's observation referred to above but not known at that time of the very rapid (monthly) filling and emptying of the gonads in the sea-urchin, Diadema: it is also worthy of note that Gray (Proc. Camb. Phil. Soc., xx. pt. 4, 1921) has described isolated cases of apparent and true hermaphroditism in the sea-urchins Arbacia and Strongylocentrotus. In *Echinus miliaris*, however, no definite hermaphrodites were found, but in several gonads at about the period of change from the spent condition to the rematuring stage, a small quantity of sperm was found together with gonocytes apparently too large for spermatocytes, and gonads were found having a colour generally associated with one sex but with young sex-elements of the other sex. The female gonad in *E. miliaris* varies in colour from white when young to yellow or orange when mature, whereas the male gonad varies from brown to grey. These differences of colour are undoubtedly an outward expression of the differences in metabolism in the sexes leading up to—or consequent upon—the production of mature sex-elements.

A similar sexual colour difference is observable in the gonad of other animals; for example, in *Crepidula fornicata* the gonad in the male stage is brownish red but yellow in the female, while that of the hermaphrodite stage is orange, and it has already been shown (Orton, Proc. Roy. Soc., vol. 81, B, 1909) that in the case of Crepidula the primary sexual characters precede in development and forecast the appearance of the secondary sexual characters. Thus the colour of the gonad in animals is undoubtedly closely connected with deep-seated changes—probably induced by sex-hormones or, as Geoffrey Smith visualised them, sexual formative substances—which are different for the mature male and female condition, and apparently also for a potential condition of sex while sex is yet unrecognisable in the primary sex-elements.

It would, therefore, seem possible that a chemical test might be devised to detect a sex-potentiality in an undifferentiated gonad. Such a test if obtained would be a very valuable help in investigating suspected cases of sex-change, especially in cases where a change-over of sex may occur between successive periods of growth of the gonad as is possible in *Echinus miliaris*, *Mytilus edulis*, and other animals, but more probable in the case of the common limpet, *Patella vulgata*. In this kind of sex-change the residual sex-elements in a gonad would often give a clue to the recent sex-condition, while the chemical test would provide evidence of the forthcoming or potential sex-condition.

The rapid change-over of sex in the oyster is also very strongly suggestive of the existence of a sex-hormone, as the gonad in a female-functioning oyster normally changes over quite suddenly after the extrusion of the ripe ova to the production of male elements only. There is good ground, therefore, for looking for a chemical test for sex-potentiality, especially in invertebrates, and there is no doubt that our knowledge of sex-conditions would increase rapidly after the discovery of such a test.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, May 24.

[1] This fertilisation and the one at Plymouth on October 29 were made by Mr. A. J. Smith. The larvæ from the Whitstable urchins November 3, and the Plymouth ones October 29, showed a fine apical tuft of cilia, which appears not to have been recorded in *E. miliaris*, although MacBride has described a similar tuft in *E. esculentus*.

An Einstein Paradox.

The letter with the above title in Nature of June 2, p. 742, contained two oversights which I should like to be allowed to correct.

1. In the second part I inadvertently changed the meaning of x'. Overlooking the fact that x' in the first part meant, by implication, the distance of K_1 from L at the time that the light reached him, I used it in the second part as the distance K_1L at the instant the signal was given. I should have employed a different letter, x_1; and then, if required, $x' = c/(c+v)$ of x_1.

2. A term was omitted from the value of x', which should have been $(1+v/c)x - vt$.

R. W. Genese.

40 London Road, Southborough,
June 13.

The Concilium Bibliographicum.

My attention has been directed to a statement in Nature of April 28, p. 584, made in connexion with the report of a meeting concerning the "Zoological Record." It is stated that "With the exception of the 'Archiv für Naturgeschichte,' which is about nine years behindhand and consequently of very little use, the 'Zoological Record' is at present the only bibliographic guide to zoological literature being published in the whole world."

Permit me to recall that the Concilium Bibliographicum at Zurich, founded in 1895 by Dr. Herbert Haviland Field and approved by the International Zoological Congress, is still continuing his work. After Dr. Field's death in 1921, the Concilium was placed under the auspices of the Swiss Society of Natural Sciences and the United States National Research Council, and has published since that time volumes 30 and 31 of the "Bibliographia Zoologica," containing an international review of zoological papers. Two other volumes (32 and 33) are already in progress of publication.

J. Strohl,
Director of the Concilium Bibliographicum.

49 Hofstrasse, Zurich,
May 15.

[We have also received a letter from Messrs. Louis B. Prout and George Talbot, of the Hill Museum, Witley. They suggest the issue of cards so that "subscribers would have the current literature available say every month, and no one would be obliged to purchase sections which would not be useful to him." They too direct attention to the reorganisation of the Concilium Bibliographicum and strongly urge co-operation with it.

Zoologists will be glad to learn that the Concilium Bibliographicum is still in being. There was some excuse for the incorrect statement to which Dr. Strohl objects, for inquiry at the two chief zoological libraries in London has failed to produce a volume of "Bibliographia Zoologica" later than vol. xxx., which, though it purports to deal with the literature down to the end of 1920, is mainly composed of titles from 1915–1917; it also omits Lepidoptera, Hymenoptera, and Vertebrata. But, even were "Bibliographia Zoologica" more up-to-date, more complete, and more accessible, its plan scarcely enables it to compete with the "Zoological Record" for the support of systematists. In the past the peculiar contribution of the Concilium has been the separate cards, but we have not seen any of these for a long time. We hope their issue has not ceased, for it is along those lines that co-operation seems most promising. If the Concilium could furnish the titles completely and promptly, the Zoological Recorders could work up the analytical index they have been accustomed to provide. We may remind Messrs. Prout and Talbot that the several sections of the "Zoological Record" have been sold separately for the past twenty years.—Ed. Nature.]

Educational Problems of Tropical Agriculture.

It is exceedingly important at the present moment that the attention of men of science should be directed to some of the needs and problems connected with tropical agricultural education. As many readers of Nature are aware, a college of tropical agriculture, the only one of its kind with pretensions to University standing within the Empire, was opened last year in Trinidad, and the ultimate success of this institution, both from the point of view of education and research, will, quite irrespective of financial support, depend upon the institution's outlook and policy and, what is equally important, the degree of acceptance which this receives in Great Britain and America.

In England agricultural colleges have not, from an academic point of view, achieved a very high status; nor have they been free from adverse criticism on the part of practical farmers. The policy of the institutions, therefore, has been somewhat unstable, tending to oscillate between the solar force of the universities and the lunar attraction of the practical farmers. This condition has been produced through misunderstandings on the following points: (*a*) the nature of agriculture; (*b*) the definition of the word "practical"; and (*c*) the difference between education and instruction.

Agriculture is to some extent an art and to some extent a profession, but fundamentally and comprehensively it is a business, or, if another term be preferred, it is biological industry. The trouble has been that most students of agriculture have thought of it as a profession, whereas the practical farmers have regarded it as an art. By definition, both are wrong fundamentally. Unenlightened, the students have tended to specialise in applied natural science (often of questionable quality), while the farmers have been the advocates of concentration on the art ("real practical work"). The misunderstanding as to the word "practical" is, therefore, clear. Neither is practical; for agriculture is fundamentally economics, in which faculty practical work can be purely intellectual, for example, accountancy and statistical inquiry. Misconceptions as to the meaning of practical have been responsible for confusion as to the difference between education and instruction. The word instruction should be relegated with patent rights to the Army, Navy, and Police Force. Except as connoting the routine of one person telling or showing something to another, it means nothing and leads to nothing. Education implies understanding and a training of the faculties including the practical instincts. Instruction alone is useful for those who do not want to be, or are incapable of being, educated; but matriculated students, such as one now finds in agricultural colleges, ought to be anxious for, and capable of, some education.

In the tropics, the so-called agricultural education of the past has been little more than instruction. A youth has been instructed how to read a polariscope or do a Babcock test—and becomes a chemist! Another is taught to bud oranges or run a sugar mill, and becomes a planter. This has suited the tropical temperament and climate, and in most cases, it is to be feared, the average type of mentality. But if tropical agriculture is to advance we must aim at, and insist upon, higher standards. The planter of the future must be taught to think and to understand his economic and biological universe. This is realised at the West Indian Agricultural College, but are we going to live up to it? Will such an outlook receive the support of tropical public opinion on which we are so largely dependent for funds? Is it, for the present, to be expected? It is therefore important that the matter should be appreciated by scientific opinion in this country to which scientific workers in the Crown Colonies look very largely for encouragement and protection.

Reference to research has been purposely avoided in the above observations for the sake of simplicity. But research, the mother of scientific education, has also its disabilities in the tropics. Up till quite recently, the demand, the popular demand, has been for "trouble-curing" rather than research. The present danger, however, is that research work may be interfered with through depriving investigators of their time in order that they may give instruction.

W. R. DUNLOP.

West Indian Agricultural College,
14 Trinity Square, E.C.3.

Gravitation and Light-Pressure in Nebulæ.

IN NATURE of June 16 there is a most interesting letter by Dr. Jeans on my suggestion that spiral nebulæ may consist of dust repelled from the stars by light-pressure. My original note must, I fear, have been somewhat misleading to have called forth the particular criticism which Dr. Jeans's letter contains. As was, I think, brought out in the discussion at the Royal Astronomical Society, it was never my intention to suggest that the dust clouds are so thick that there is any appreciable shielding; indeed it is perfectly obvious, as Dr. Jeans points out, that the whole theory would break down unless the particles are assumed to be so far apart that they can be treated individually.

The misunderstanding is due to a somewhat ambiguous sentence at the end of the paper, which I admit is capable of giving quite a wrong impression. I had anticipated that my suggestion would be criticised unless I presented some explanation of the so-called "novæ" in spirals. The suggestion put forward was that they were similar to terrestrial meteoritic showers. In order to show that this was not impossible I put in some very rough quantities, and endeavoured to show that they would not lead to absurd results for the characteristics of the nebula. The density found, based, it may be remarked, upon the time in which the meteoritic stones are supposed to evaporate, leads to a mass over the depth of one light-year of 0·1 grams per square centimetre. I agree, of course, that this cannot be supported by radiation pressure; indeed a remark by me to the same effect may be found in the *Observatory* some years ago. It would have been better had I said that this result was some 10^3 times too high in view of the obvious transparency of parts of the spirals. The great uncertainty of the quantities used, however, emboldened me to say this was of the right order of magnitude; compared with the results derived from other hypotheses to account for the "novæ," which led to results 10^6 times greater, this was perhaps excusable.

Dr. Jeans's criticism, to which I admit my somewhat optimistic sentence laid me open, applies, therefore, to that part of my paper from which this unduly large mass was derived; *i.e.* the hypotheses introduced to account for the "novæ." It is possible that the quantities which I used might be altered plausibly to give a more acceptable value. It is perhaps even more likely that a more satisfactory hypothesis may be evolved to account for the phenomenon. But the main outlines of my suggestion do not seem to be controverted.

F. A. LINDEMANN.

Clarendon Laboratory, Oxford,
June 16.

The Heape and Grylls Rapid Cinema.

OWING to arrangements deemed necessary at the Soirée of the Royal Society on June 20, I was unfortunately deprived of the opportunity I had hoped there to gain, of making a personal explanation which is important to me and which I beg to be allowed to make in NATURE.

The conception of devising a camera wherewith photographs could be taken at the rate of 5000 a sec. occurred to me in consequence of some chance remarks made to me by an official of one of the great armament-producing companies in this country. The lion's share of credit for the successful completion of the design of the camera, however, is due to my friend Mr. Horace B. Grylls, who became partner with me in this adventure in 1914; while both of us are indebted to my friend Prof. Boys, who, as all who know him will readily believe, gave us with both hands all the help and advice he had to give.

The interest which has lately been aroused by the exhibition of some of the films I took while the machine was still in Messrs. Thos. Cooke and Sons' workshop in York—experimental films and far from perfect, I regret to say—calls for some such statement as I now, with great satisfaction, make here.

WALTER HEAPE.

Manor Lodge, Tunbridge Wells,
June 21.

Adsorption and Hæmoglobin.

SIR WILLIAM BAYLISS has pointed out, in NATURE for May 19, p. 666, that he is unable to find any account of experiments on the dissociation curve of hæmoglobin at gas pressures considerably greater than that at which the hæmoglobin is presumed to be saturated. He seems to imply that there is no proof that hæmoglobin cannot take up more gas than is required by the theory that a chemical compound is formed, in which one molecule of O_2 or CO corresponds to one atom of iron.

The point is important, not only as evidence on the relative merits of the chemical and adsorption theories, but also because experimental methods of determining the oxygen dissociation curve depend on the assumption that hæmoglobin becomes completely saturated, in contact with air, at the ordinary temperature of the laboratory.

I have tried to test this question by shaking equal samples of the same blood (partly reduced) in the Barcroft differential apparatus, (1) with the bottle filled with air in the ordinary way, and (2) with the bottle filled with a mixture of air and CO, containing rather more than half an atmosphere of CO.

It is known that hæmoglobin takes up CO more than 200 times as readily as oxygen, so the effective gas pressures in the two cases were in the ratio of at least 500 : 1. If the hæmoglobin takes up gas by adsorption, one would expect to find appreciably more CO taken up than oxygen. As a matter of fact, a little more CO was taken up, but only that quantity which is accounted for by the difference of solubility of CO and air in the liquids present (blood and dilute sodium carbonate solution).

There was no evidence that the hæmoglobin itself

2 C 2

took up any more CO than oxygen, in spite of the great difference between the effective concentrations of the two gases.

Sir William Bayliss also asks for experimental tests of the assumption that oxyhæmoglobin is a stronger acid than hæmoglobin itself. The limitations of the hydrogen electrode make the measurement of the hydrogen-ion concentration of hæmoglobin solutions, in the presence of oxygen, a difficult problem. I have been able to show, however, that if gas is boiled off in a vacuum from dialysed hæmoglobin solution, the electrical conductivity of the solution is considerably increased by shaking with oxygen or CO. (Precautions have, of course, been taken to exclude the possibility of the increased conductivity being due to impurities in the gas used.)

While this is naturally not a proof that combination with oxygen increases the acid dissociation constant of hæmoglobin, it is nevertheless the result to be expected if this be the case, and is a fact to be explained by any theory, chemical or physical.

Prof. Hill and I have pointed out that the divergent results of investigators of the heat of combination of oxygen and hæmoglobin may be due partly to bacterial action, and (in experiments on blood) partly to failure to allow for the heat changes involved when oxyhæmoglobin turns out CO_2 from carbonates. By eliminating these sources of error we have been able to get quite consistent results in experiments on defibrinated blood.

Without making any assumptions other than the recognised laws of chemical combination and chemical equilibria, it is possible to explain the behaviour of hæmoglobin by regarding its reactions with CO and oxygen as purely chemical. Sir William Bayliss has said that he doubts whether it is justifiable to apply these laws to a system in which the number of the phases may be uncertain. Surely the best way to decide this is by results, and, judging by results, the chemical theory has amply justified its position as a fruitful working hypothesis.

Can the adsorption theory explain the phenomena so completely, with so few untested assumptions? Since the paper by Wo. Ostwald in 1908, no attempt has been made, so far as I am aware, to put forward a complete theory of the reactions of hæmoglobin as adsorption phenomena. Much experimental work has been done since then, and until such a theory is put forward it is difficult to weigh up satisfactorily the merits of the two views.

At present the adsorption theory is in danger of going by default.

W. E. L. BROWN.

Physiology Department,
University of Manchester, June 4.

A Puzzle Paper Band.

AN easy solution of the paper-band puzzle described by Prof. C. V. Boys in NATURE of June 9, p. 774, is obtained as follows: Hold the hand with thumb up and palm towards you; place the paper band over the index finger, letting the ends hang down. Observe which way the original four half-twists were applied. Treat the nearest of these to the index finger on the palm side of the hand as if it were that of an ordinary single half-twist band; which complete, by looping up one-half of the band over the finger (the other twists being pushed out of the way into the remaining half). Then apply the surfaces one upon another at the finger; and turn the other half of the band inside out so as to get rid of two of the twists. It will be found to fit exactly upon the first half, as required.

ANNIE D. BETTS.

Hill House, Camberley, Surrey, June 11.

Paradromic Rings.

PROF. C. V. BOYS, in his letter "A Puzzle Paper Band" in NATURE of June 9, p. 774, gives scant credit to the geometers. Forty years ago they described the endless band of paper with a half-turn twist in it, and found that if cut down the middle line it gave a single endless band with four half-twists. But they were so obsessed, he says, with the consequence of cutting down the middle line that they missed the result he now describes. This consists in taking a band with four half-twists and converting it by manipulation into a half-twist band of double thickness.

But the difference between the known result and the proposed novelty seems not more than trivial: for if the medially cut band has its adjacent half-widths simply slid sideways, one over the other, along the entire length of the band, the double-thickness band of half-width is at once produced. Or, reversely, if the pulleys of Prof. Boys are made twice as wide, and the outer band is teased sideways at its entry on to each revolving pulley, the two halves of the band will presently come edge to edge throughout and are then seen to be nothing but the half-twist band medially cut.

As regards this lateral shifting, it is obvious that any endless band, however much twisted and knotted, may, when cut down the middle, be continuously "shuffled," in the way in which a "pack" consisting of only two cards may be shuffled. Each neighbour slides over the other in perpetual oscillatory contact, alternately face to face and edge to edge. Two different superpositions and two different edge-to-edge positions occur alternately and cyclically. In particular, the band with four half-twists may be arranged as a two-ply half-twist not in one way only but in either of two ways. For either of the two different faces of the former may be completely exposed or completely concealed in the latter.

The sheer puzzle of the manipulation Prof. Boys plans to make even harder by varying the sense of the twists, as right-handed or left-handed. I should propose (somewhat on behalf of the geometers) to escape this difficulty by letting the paper discriminate for itself. The instructions would be these. Strip the band along, two-handedly, until the twists are concentrated on a short section. They come to form roughly a circular cylinder, showing two turns of a ribbon screw. Take two adjacent widths, touching helically edge-to-edge at any point, and fold them together as if closing an open book. Then feed the short circuit at the expense of the long loop until they come equal, and fit together by stripping. These operations may quite easily be done blindfold.

Prof. Boys says that the double band shows only two of the half-turns, and that it is amusing to find where the other two have gone. But this is *vieux jeu*: for Tait explained it in his first paper on "Knots" in 1877; and he was only following Listing, who had these things clear in his "Topologie" of 1847. If the paradox is still alive it may be reinforced, for those who do not know that torsion and curvature are convertible; for the double-twist may be hung over one finger as a festoon of three equal loops, with the six pendant planes all (approximately) parallel to the finger, and then not merely half but the whole of the twist appears to have gone.

In a parenthetic confession Prof. Boys admits that he made his discovery while lying awake one night; but this may almost be interpreted as an indirect testimonial to the day labourers.

G. T. BENNETT.

Emmanuel College, Cambridge, June 12.

Chemical Symbols and Formulæ.[1]

By Sir JAMES WALKER, F.R.S.

SYMBOLS are both an aid and an obstacle to thought. Their brevity and simplicity may help us, working according to a fixed system, to perform mental operations which without their aid might be practically impossible. Their generality too may, as in algebra, enable us to solve thousands of problems in one. On the other hand, we sometimes find in science a system of symbols which, at first of great value, may in virtue of its very success so warp our thought or limit our mental outlook as to constitute a real hindrance to scientific progress. There is always the danger, arising from our familiar and constant use of the symbol, either of forgetting what it properly symbolises, or of confusing the symbol with the thing symbolised.

The function of the symbol is a practical one; in Mach's phrase, it is to effect economy of thought, and it is precisely because mankind at large is so economical of thought that the dangers of symbolism originate. The danger, however, must be faced by the student of chemical science, for without symbols systematic advance is impossible: the symbols are based on a theory and permit the representation of that theory in detail.

If we examine the practical requirement of a satisfactory system of symbols, we shall find that the system must be simple in itself and simple to operate. Consider the Roman schoolboy confronted with the problem of multiplying MCMXXIII by CXLIV. The system of notation is not too complicated, but to operate with it is practically impossible. To perform his task he must abandon the symbolism and have recourse to concrete objects—the fingers or an abacus. The Arabic notation, on the other hand, with its consistent valuation by position and the introduction of a symbol for zero, enables us, once we have passed the barriers of the addition and multiplication tables, to perform arithmetical calculations of all kinds with ease and speed. It is simple in itself and simple to operate.

The same requirements are essential to a system of chemical symbols. The first symbols, those for the metals known to the ancients, indicated nothing but their supposed association with the planets and the gods ruling them. Thus the solar disk stood for gold, the lunar crescent for silver, the mirror of Venus for the Cyprian metal copper, and so on. Towards the end of the eighteenth century we see the beginnings of our present system of elementary symbols. Hassenfratz and Adet (1787) used for the non-metals straight and curved lines which could be combined together (much as in phonetic shorthand) to represent the qualitative composition of compounds. The symbol for a metal was a circle, and to distinguish one metal from another the initial of its Latin name was written within the circle—thus (Sb) was the symbol for antimony.

Dalton used for metals and non-metals alike only circular symbols, doubtless to represent spherical atoms, and in his hands the symbols assumed a quantitative significance based upon his atomic theory. For the simple non-metals these symbols were arbitrarily chosen, ○ representing an atom of oxygen, ⊙ an atom of hydrogen, ⦶ an atom of nitrogen, and so on. For the metals he adopted the same device as Hassenfratz and Adet, using, however, the English instead of the Latin names, so that for example (L) represented an atom of lead. Compounds could be represented by the juxtaposition of the elementary symbols, which now gave, not only the qualitative, but also the quantitative composition of the compound. Thus, for Dalton, water was represented by the symbol ○⊙, denoting the combination of 7 parts of oxygen with 1 of hydrogen.

Berzelius (1815) took the final step by using Latin initials for all the elements, dropping the circles which had surrounded them, and employing affixed numerals to indicate the number of times the symbol had to be repeated. It is true that Berzelius spoiled the uniformity of his system by using a special dot symbol for oxygen and writing such formulæ as $\dddot{S}$ for sulphur trioxide. These dotted symbols, however, found little favour except amongst mineralogists, and gradually passed out of use. The disuse of the circles is not without significance—the symbol to Berzelius represented a combining weight rather than a concrete atom, and the dual quantitative use persists in the interpretation of symbols to-day. The symbol C stands for one atom of carbon or "twelve parts by weight" of carbon. So we may say that more than a hundred years ago a system of formulation had been reached which, with minor alterations, is in use at the present time for the representation of elements and the composition of compounds, and is never likely to be superseded. It is uniform, plain, and simple in itself, and simple to use in the equations representing chemical change.

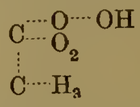
The purely compositional formulæ, however, fall far short of expressing what calls for expression in various classes of chemical compounds: action and structure have to be considered as well as composition. The dualistic formulæ of Berzelius illustrate early attempts in this direction. The formula of sodium sulphate is not written empirically as Na_2SO_4, but dualistically as Na_2O,SO_3. This formula indicates *inter alia* that the sodium and the sulphur belong to two essentially different parts of the compound. The modern electrochemical dualism writes Na'_2SO_4'', again indicating the same division of a positive from a negative portion. In organic chemistry the representation of structure by means of formulæ achieved success by the clear recognition of valency—in particular, the quadrivalence of the carbon atom. At this point of development the notion of the atom as structural unit becomes indispensable.

The valency of an element on its experimental side is in essence a numerical conception. We divide a weight by a weight, namely, the atomic weight by the equivalent weight, and obtain in consequence a mere number. When we pass from element to atom, however, the conception undergoes a transformation, and receives a concrete meaning. The valency of an atom may be interpreted as its capacity for combining with other atoms, again a numerical conception, but one

[1] Presidential address delivered at the annual general meeting of the Chemical Society on March 22.

leading directly to a symbolism and indirectly to a mechanical interpretation. Each atom is conceived as having a definite number of places for the attachment of other atoms, and as the number is in each case small we can conveniently represent it in a graphic symbol.

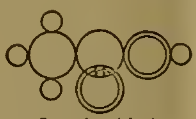
It is not without interest to look back to the origin of graphic or constitutional formulæ and see the beginnings of our conventional system. Couper and Kekulé, the originators of the idea, suggested systems widely differing from each other. Couper (1858) symbolised acetic acid as follows,



in appearance a near approach to present-day usage if we allow for the fact that he assumes O=8 and C=12. The manner of linking of various atoms is indicated, but their valency is not clearly symbolised. Kekulé's graphic formula (1859) for the same substance is shown below.

Acetic Acid.

(Kekulé.)

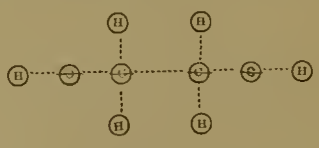


(Loschmidt.)

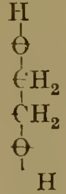
The valency is satisfactorily represented, but the linkage of the atoms is confused. Only atoms touching in a vertical line are supposed to be directly linked. The system is cumbrous, and Kekulé himself used it but sparingly. For branched chains it becomes impracticable.

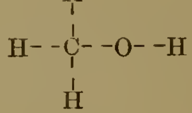
Loschmidt (1861) devised a clear logical system which, although he formulated by its means hundreds of compounds, some of a very complex nature, found no favour amongst chemists. His symbol for acetic acid is given in the figure. Here linkage and valency are adequately represented, but the atomic symbols are arbitrary, and the system, like Kekulé's, is cumbrous to use.

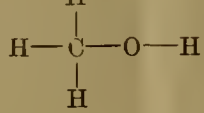
Simultaneously with Loschmidt, Crum Brown (1861), although he was unaware of Couper's work, used a symbolism resembling his, and practically identical with that in current use. He writes glycol as follows:



Here valency and linkage are clear, and the atomic symbols are no longer arbitrary. Wurtz in 1864 gave the following formula (I.) for the same substance:

(I.) 

 (II.)

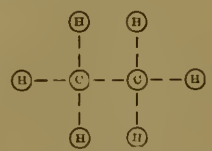
 (III.)

The line of development of modern graphic formulæ, then, is through Couper, Crum Brown, and Wurtz, and not through Kekulé or Loschmidt. The reason for the preference shown by chemists is that the symbolism adopted is more obvious, simpler to use, simpler to reproduce, and easily adaptable to all organic compounds.

There is a dual character in our graphic formulæ which it is important that we should realise. Let us begin with the graphic symbols of the elements, thus:

H–, –O–, –C–, where each short line represents a unit of valency. To the graphic symbols of molecules is but a step; the atoms are represented as united together, the valencies indicating the manner of attachment (II.). The directness or indirectness of union of the atoms is here given; no hydrogen atom is in this formula directly attached to another; they are only indirectly united through carbon or oxygen. For brevity, we join up the lines representing the valencies of the various atoms and obtain the customary formula (III.). A great change in significance has, however, at this stage taken place: the valencies have become "bonds"—the idea of force has entered. What that force is remains indeterminate; it is merely something binding atoms together, and the interpretation of the symbols is not quantitative in this respect. The "bonds" do not represent equal forces; it is patent that the bond between hydrogen and carbon in the formula for methyl alcohol represents a different force from that between hydrogen and oxygen. The current symbolism may then be interpreted in two senses; the lines joining the atomic symbols may be taken to represent on one hand merely the union of the atoms to the symbols of which they are attached, or they may represent forces existing between these atoms. Confusion of these two senses sometimes leads to erroneous reasoning.

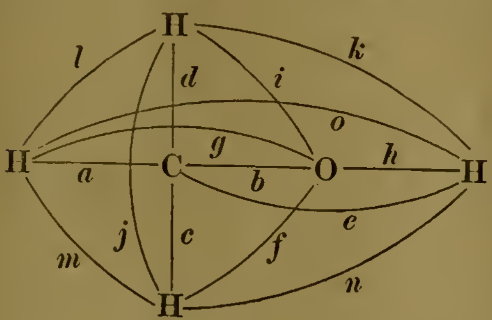
This dual character of graphic formulæ is noticeable from their earliest employment, and I need make no apology in illustrating it from the work of Crum Brown, whose recent death deprived our Society of its senior past-president. In the formula for glycol quoted above he states (1861) that the dotted lines therein employed represent polar forces. In 1864 he represents ethane thus (IV.),

(IV.) 

 (V.)

each valence being written independently. He says: "I may here shortly explain the graphic notation which I employ to express constitutional formulæ. . . . An atom is represented by its usual symbol surrounded by a circle with as many lines proceeding from it as the atom contains equivalents. . . . When equivalents mutually saturate one another the two lines representing the equivalents are made continuations of one another." Here he has discarded the idea of polar force in his original formulation in favour of the simpler conception of number of equivalents. In 1866 he writes continuous lines between the symbols, and in 1868 puts the matter thus: "The structural formula of formic acid [V] indicates first, that the four carbon equivalents form one atom, the four oxygen equivalents two atoms, and the two hydrogen equivalents two atoms; secondly, that these equivalents are united in pairs, thus—*co, co, co, ch, ho*; but it does not in any way indicate (and we do not know) what is the *potential* of each of these pairs—that is, how much energy would be required to separate the equivalents from each other. We know that this potential depends upon the structure, and we can to a certain extent trace the nature of this dependence, but as yet we cannot express the potential numerically, and till we can do that we do not fully know the constitution."

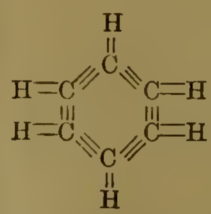
On one hand, then, our "bonds" stand for mere units of valency; on the other, they are an imperfect representation of forces. Were the representation of forces more complete, methyl alcohol would appear somewhat as shown in the figure below, the small letters representing numerical values. Even this formula, however, only gives the magnitude and not the real direction of the forces, and is besides static, not kinetic. We naturally shrink from complexity such as this: imagine the formula of sucrose on a similar basis. We must content ourselves with something simpler, and

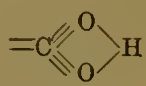


Methyl Alcohol.

yet the simple valency formula has for long been felt to be inadequate. Apart from the idea of definitely directed valencies which leads to stereochemical formulæ, the idea of representing partial valencies has been constantly in the foreground. We cannot properly split valencies in the old sense, but we can subdivide forces *ad libitum*. If the subdivision is carried too far, however, the formulæ may approach in complexity formulæ with quantitatively measured forces, such as that indicated in the figure.

What the chemist requires in his system of formulation is something, not which he can *measure*, but which he can *count*—counters, in short. Such numerical counters he possesses in valencies, in co-ordination numbers. He may be forced to consider the adoption of counters of different kinds, for the purpose of representing essentially different distributions of force; but these counters, if they are to be of general practical value, must neither be too numerous nor of too great variety. Partial valencies, augmented valencies, diminished valencies, virtual valencies, represented by lines of various sorts, thick, thin, curved, dotted, etc., all tend to complicate formulæ, which lose in obviousness what they gain in definition. The humiliating fact must be admitted that the average man does not succeed in counting quickly and accurately by inspection any larger number of "bonds" than he has fingers on one hand, unless they are appropriately grouped—witness the wrong valencies found, not merely in examination scripts, but even on the printed page. We ought, then, to set strict limits to the splitting of "bonds" and the issue of fractional valency counters. Fortunately, the physicist has provided us with a new counter, the electron, which has the great merit of being a physical reality, and, moreover, of being an undecomposable magnitude, so that there is no temptation and no possibility of dividing it further. This counter enables us practically to halve ordinary valencies, and so offers many advantages. In the original form given by J. J. Thomson, lines in the formulæ are made to represent tubes of force passing from an electron of one atom to the positive core of another, and since in electrically neutral atoms, for each tube of force which passes out of an atom a return tube must come in, directly or indirectly, one valency line on the old scheme is represented by two tubes of force on the new. The new formulation enables us to write, for example, symmetrical formulæ for benzene and for the carboxyl group, if we so desire, thus:





Or, again, we may represent the valency electrons directly in our formulæ, each atom being equipped with its doublet, sextet, or octet. Such formulæ, or modifications of them, are coming extensively into use when multiple bonds are in question, and there is no doubt that with the electron or electronic tube of force as counter we obtain a more adaptable and more flexible formulation of organic compounds than that afforded by the older valency formulæ, although only with some sacrifice of their simple character.

It will be gathered from what I have said that my plea is for the utmost obviousness of our symbols and formulæ. Their content and connotation may be as rich as we please; the symbols themselves should be of elementary simplicity. But, it may be asked, why should we seek to limit the investigator striving for chemical self-expression to four whole valencies for carbon if he wants a dozen partial valencies to facilitate his own thought or to convey his exact meaning? And why should he hesitate to adorn his formulæ with arrows or positive and negative signs of polarity if he feels the necessity? The answer to such questions must be of a practical nature. The investigator for his own use may employ a symbolism as elaborate and as complex as he chooses, but if he wishes to secure the understanding and sympathy of others he must curb any spirit of exuberance. A system of chemical formulation to have general currency must not be too elaborate. Otherwise, although it effects economy of thought to the expert who devises it, it may demand such a mental strain of the general chemical reader as to defeat a main purpose for which it was planned, namely, the communication of knowledge. I would quote, both with regard to chemical symbolism and to chemical nomenclature, the words used by a character of Henry James concerning literature, "The observer is nothing without his categories, his types and varieties. . . . That's for his own convenience; he has privately a terminology to meet it. . . . But from the moment it's for the convenience of others, the signs have to be grosser, the shades begin to go. . . . Literature, you see, is for the convenience of others. It requires the most abject concessions." Scientific literature is, above all, for the enlightenment and convenience of others, and scientific specialists must be prepared to make concessions to their weaker or less expert brethren. But whether the symbols we use are simple or complicated, we should always be clear as to their true significance, and be on our guard against their distracting our thoughts from the realities which they partly reveal and partly obscure.

Recent Contributions to Aviation Problems.

By Prof. G. H. Bryan, F.R.S.

The attempts which have hitherto been made to explain the continuous sustentation of tropical and other birds without the performance of muscular work have left many doubtful points requiring to be cleared up. Observers have frequently sought to attribute the phenomena to something acting in violation of the principles of elementary mechanics, and have succeeded in establishing this peculiarity, not perhaps in the way that they intended, but by the chaotic way in which such terms as force, momentum, weight, energy, lift, pull, drag, and gravity are confused by them, and occur indiscriminately mixed up in their writings. In a paper on "Meteorology and the Non-Flapping Flight of Tropical Birds," published in the Proceedings of the Cambridge Philosophical Society, xxi. 4, Dr. Gilbert T. Walker has now sought to bring sound scientific principles to bear on the numerous observations in India published by Dr. Hankin. From observations of the temperature of the air at Agra at different altitudes and hours of the day, Dr. Walker finds conditions of instability leading to the formation of strong ascending air-currents, and observations in Egypt and various parts of India indicate conditions of "bumpiness" in the atmosphere caused by ascending currents, covering the periods employed by birds for "soaring."

Dr. Walker finds that the angle of gliding of the most efficient recent aeroplanes is sufficiently low to satisfy the conditions necessary for continuous sustentation in the presence of these currents, and he examines in detail three possible sources of internal work in the atmosphere, namely, ascending currents, variations of horizontal velocity as functions of time and place co-ordinates, and Lord Rayleigh's hypothesis of variation of horizontal wind velocity as a function of the vertical altitude co-ordinate. He also carefully considers the structure of the birds' wings, in comparison with those of the Handley-Page machine, and the effect of the flexibility of the quills on the aerofoil form in ascending and descending glides. Both from theory and from actual observation, it is found that the ascending air-currents in the higher regions of the atmosphere are greater in diameter than lower down, and from actual observation he contradicts Dr. Hankin's statements according to which birds are seen rising in descending currents. It would thus appear from Dr. Walker's observations that, in the region dealt with by Dr. Hankin, the atmosphere possesses sufficient internal energy to satisfy the conditions of "soarability" required by the latter observer. In regard to the violation of mechanical principles, both hypothetically by birds and actually by writers, we cannot do better than quote Dr. Walker's remark that . . . "it is strangely" (asterisk and footnote with references follow) "necessary to insist that it is as impossible to derive energy from a wind that is constant in time and space as it is from a perfect calm." To theories based on a denial of this principle the late Sir Hiram Maxim used to point out the enormous velocity of the wind due to the earth's rotation and its orbital motion about the sun, and he suggested that if writers believed in these theories, why did not they utilise this energy for the purposes of flight?

The recent records of gliding flight in the daily press afford ample confirmation of Dr. Walker's theories in regard to the quantity of *available* internal energy present in the atmosphere. When we read of aviators remaining for hours in the air under climatic conditions not widely different from those prevailing in Dr. Hankin's and Dr. Walker's investigations, and of 7 horse-power engines making long flights at a cost for fuel of not more than a penny a mile, we have reasonable prospects of realising a system of cheap transport largely superseding the use of wheels bumping over stony roads or iron bars placed end to end.

Apart, however, from the precariousness of the distribution of the necessary internal energy in space and time, a motorless aeroplane is in constant danger of being suddenly brought to rest relative to the air, or, more accurately, losing all headway, at which instant it has a vertical acceleration due to gravity, and the resistance to rotation (pitching, yawing, rolling) becomes technically describable as "a small quantity of the second order," thus approximating to the conditions assumed in the problem of rigid body rotation under no forces.

We are constantly reading of accidents which seem to suggest that they have arisen from this condition of affairs, even in the case of motor-driven machines which are at least equipped with a more adequate means of extricating themselves from this eventuality.

No system of aviation will ever be satisfactory, however, until backed up by a more thorough solution than we now have of the equations of motion of the "perfect aeroplane." Perfect fluids, perfect conductors and dielectrics, perfectly smooth bodies, perfect gases, and so on, are very familiar terms, but the "perfect aeroplane" has not yet figured in literature as such, though various formal representations have been proposed for it from the time of Lanchester's phugoid system down to the systems of Brodetsky and the present writer. These last systems reduce the study of the perfect aeroplane to the solution of a system of assumed and stated equations, in fact a problem in pure mathematics only.

If the conditions necessary for steady motion (under forces in equilibrium) and inherent stability are satisfied, an aeroplane will tend to assume a state of steady motion provided that the initial conditions represent a sufficiently small displacement from the steady state. But under widely different initial conditions it may tend to assume an altogether different motion, and, for example, it may sooner or later lose headway or crash to the ground, pitching over and over. We are thus led to considerations of *superstability*, an inherently *superstable* aeroplane being defined as one which, like a non-capsizing lifeboat, will tend to assume a state of steady motion whatever be the initial conditions of projection; failing that, to investigate the limits of superstability; in other words, the limiting initial conditions under which the machine tends towards instead of away from steady motion. It is clear that such an investigation will involve the search for periodic solutions of the equations of motion which, though difficult, should not be harder than many problems on which pure mathematicians have set their faces. In condition with lateral displacements a spiral gliding motion would represent one limit of superstability, but there are probably others which may or may not occur in practical applications. At present Dr. Brodetsky appears to be the only applied mathematician who has really made substantial advances tending in this direction.

It seems rather probable that further developments will involve the solution of integral equations.

Possible future applications to the location of aircraft are suggested by a paper by Dr. A. B. Wood and Capt. H. E. Brown on "A Radio-acoustic Method of locating Positions at Sea," read before the Physical Society on March 9, and the discussion thereon, in which Capt. Fowler, Major Tucker, and others took part. In this method a wireless signal is made at the same instant that a charge is fired into the sea, and the times of arrival of both signals are recorded at land stations, thus determining the distance of the ships from them. The method is obviously applicable to the sound ranging of aircraft in commercial aviation, but, as Mr. Smith remarked in the discussion, the captain of a vessel would certainly need to make the observations himself, and, up to the present, experiments on detection of acoustic signals, and especially echoes of sound signals, by means of apparatus carried on aircraft, have not been so successful as could have been wished. It is to be hoped, however, that experimental work on this subject will be continued, as the means hitherto at our disposal for location of aircraft leave much to be desired, especially if cross-country flights are to be effected at any considerable distances from the main air routes.

The possibilities of employing helium in airships are discussed by Capt. G. Arthur Crocco in the *Atti dei Lincei*, xxxii. (1) 2, 3. It is estimated that from the natural gas wells in the United States a supply of three million cubic metres per annum is obtainable, and taking twenty years as the life of a well, the cost works out at two dollars per cubic metre. This supply would not be sufficient to replenish the consumption of more than one airship in active continuous service on long-distance traffic under existing conditions, and Crocco considers in detail the different causes of loss and the means of reducing them within practicable limits. The author separates the consumption of gas into three categories, which he describes as "consumption of navigation," "osmotic diffusion," and "washing of the gas" necessitated by loss of purity, and due to endosmotic entry of air into the envelope accompanying the exosmotic diffusion of the helium. The annual losses of gas due to these three causes are in the ratio of 100, 10, 1, and it is estimated that if the first could be eliminated the annual loss of gas by an airship could be reduced to 20 per cent. of the total volume, and that a large fleet of commercial airships could be maintained in continuous working at a reasonable cost.

The "consumption of navigation" represents the amount of gas let out to compensate for the loss of weight of the fuel, and, as pointed out, this assumes serious dimensions in long-distance journeys where excessive buoyancy cannot be overcome by lowering the elevators. The necessity for this discharge of gas can be obviated in two ways, namely, by condensing the water in the products of combustion and by "thermic sustentation," and in his second paper Crocco examines the former method. It is estimated that 1000 grams of fuel contain 150 grams of hydrogen, which, combining with the oxygen of the air, give 1350 grams of water, so that by condensing this the gain of oxygen can be made to compensate for losses in other directions. The necessary superpressure to effect this condensation can be secured by means either of causing a back pressure in the motor or by separate compression. The paper contains formulæ and calculations of the amount of the superpressure required to effect the necessary condensation, and this of course is a function of the degree of saturation of the atmosphere. It is found that this only reaches a serious amount in the case of very hot and dry weather, such as in average climates only occurs on a few days in the year. Remembering that only 1000 grams out of 1350 have to be condensed, the author finds that the loss of power required for the purpose is not sufficient to interfere with the practical application of the method when the effects occurring exceptionally are reduced to annual percentages.

In a paper communicated through Prof. Levi Civita to the *Atti dei Lincei*, xxxi. (2) 1-2, Dr. E. Pistolesi employs moving axes to formulate the differential equations of motion of a fluid in the field of velocity produced by a screw propeller. In this way the problem is reduced to one of steady motion. The method is closely similar to one adopted many years ago in connexion with problems on the small oscillations of gravitating rotating fluids, with the difference that in applications of approximate methods the velocity components relative to the airscrew will not be small, but in certain cases it may be possible to regard as small the components relative to fixed axes set up by the motion of the screw.

Another hydrodynamical line of investigation which has recently come into prominence in connexion with the effects of skin friction on the resistances of aircraft is the theory of viscosity. This forms the subject of two papers in the *Atti dei Lincei*, xxxii. (1) 1, 2, by Dr. Umberto Cisotti, also communicated by Prof. Levi Civita, the first dealing with motion in canals and the second with damped waves.

The object of the present article has been to direct attention to papers published elsewhere than in the technical journals and periodicals, such as those of the Royal Aeronautical Society, the Aeronautical Research Committee, or the Institution of Aeronautical Engineers, all of which are replete with results of other important and valuable investigations.

Obituary.

Canon W. W. Fowler.

Canon William Weekes Fowler, Vicar of Earley, Reading, died on Sunday, June 3, at seventy-four years of age. He was suddenly taken ill in the vestry before the service, and died soon after service began. Having always been a man of untiring energy, we feel sure that he would have preferred to die in harness rather than to have endured any long illness.

Canon Fowler was the son of the Rev. Hugh Fowler, Vicar of Barnwood, Glos, and was born in January 1849. He was educated at Rugby, where he gained a scholarship for Jesus College, Oxford. He took a first in Classical Moderations, and a third in Lit. Hum.: he was ordained, and became a house master at Repton in 1873. In 1880 he was elected head-master of Lincoln School, where he remained for more than twenty years. Bishop King appointed him Canon of Welton Brinkhall in Lincoln Cathedral. He was Rector of Rotherfield Peppard, Oxon, in 1901–1904. In 1905 he became Vicar of Earley, in the gift of the Vicar of Sonning. In 1907 he was president of the Head-masters' Association, and for many years was an energetic member of the Reading Guardians.

Canon Fowler was best known in scientific circles as an entomologist, being a sub-editor of the *Entomologists' Monthly Magazine* from 1885 until the day of his death. He was secretary of the Entomological Society of London in 1886–1896, president in 1901 and 1902, and vice-president in 1903. He was a member of the Science Committee of the Royal Horticultural Society, and in 1906–1907 was a vice-president of the Linnean Society.

Besides writing numerous notes and articles on Coleoptera, Heteroptera, etc., in the scientific magazines, Canon Fowler's chief works were the volumes on Coleoptera for the "Fauna of British India," including the General Introduction, the Cicindelidæ and Paussidæ, published in 1912; the volumes on Hemiptera-Homoptera, with W. L. Distant, in the "Biologia Centrali-Americana," published in 1887–1909; a "Catalogue of British Coleoptera," with Dr. Sharp in 1893, and with Rev. A. Matthews in 1883; the "Coleoptera of the British Isles" in five volumes, published in 1887–1891, and a sixth supplementary volume, with Mr. H. St. J. K. Donisthorpe, published in 1913. He also published a number of text-books on the classics, etc., for use in schools.

Canon Fowler was a very broad-minded man, generous and unselfish, and was much beloved by all who knew him. He was always ready to help younger men with advice and entomological specimens, etc., and his death leaves a blank in the ranks of the older entomologists which will not easily be filled.

Horace Donisthorpe.

Dr. Hans Goldschmidt.

The inventor of the Goldschmidt thermite process, Dr. Hans Goldschmidt, died after a short illness on May 21, in Baden-Baden.

Hans Goldschmidt was born on January 18, 1861, in Berlin, where his father, in 1847, founded the chemical works of Th. Goldschmidt, of which he was the director until his death in 1873. Hans Goldschmidt studied chemistry at Leipzig, Berlin, Strasbourg and Heidelberg, where he graduated in 1886 under Robert Bunsen. After this he continued his studies in electro-chemistry and travelled in foreign countries; this widened his views on economic questions. In the year 1888 he entered, as a partner, the works of his father, in which his brother, Karl Goldschmidt, had taken the lead since 1882.

Goldschmidt's first technical achievement was the invention of an electro-chemical process for recovering the tin from white iron waste, which has found wide application in many countries. His name became famous in the year 1894, when he succeeded in reducing oxides by combustion with powdered aluminium, and by the tremendous heat of this reaction, metals of a high melting-point, such as chromium, vanadium, molybdenum, tungsten, and their alloys with iron and other metals, melt and can be produced in a pure state. As a by-product, corundum is formed, which can be technically utilised for grinding purposes. The thermite process found an even larger application by the use of mixtures of aluminium metal with iron oxide for welding together the ends of rails of tramways and for repairing broken machinery, especially of ships. Hans Goldschmidt also discovered a process for avoiding the formation of holes in iron castings and for improving steel castings by the addition of aluminium.

Hans Goldschmidt was one of the founders of the Bunsen Society for Applied Physical Chemistry, and was for many years its president. He was awarded the Elliot-Cresson-medal of the Franklin Institute. His high scientific standing and good nature will ensure for him a place in the history of technical chemistry and in the memories of his numerous friends both in and out of Germany.

We regret to announce the following deaths:

Prof. Heinrich Boruttau, a director of the Friedrichshain Hospital, Berlin, whose work was especially concerned with the relations of physics to medicine. He also worked on physiological chemistry and problems of nutrition. He died on May 15, aged fifty-four.

Dr. W. d'E. Emery, formerly director of laboratories and lecturer on pathology and bacteriology to King's College Hospital, on June 19.

Mr. E. J. Steegmann, for many years secretary to the Royal Commission on Human and Bovine Tuberculosis, on June 8, aged fifty-five.

Current Topics and Events.

The approaching twenty-fifth anniversary of Sir Ronald Ross's epoch-making discovery of the mosquito transmission of malaria is made the subject of a powerful letter in the *Times* advocating the establishment of a Ross Institute in London, to be called the Ross Clinique for Tropical Diseases. The letter is signed by the Marquess of Lansdowne and Lord Hardinge, ex-Viceroys of India, by a number of business men connected with the Tropics, and by presidents and directors of scientific societies at home and abroad. Among the latter are included the directors of the Pasteur Institutes of Paris and Brussels, of the Gorgas Institute in Panama, and of the School of Hygiene, Johns Hopkins University, the president of the International Health Commission of the Danube, and the Director-General of the United States Public Health Service. The object of founding a Ross Institute is twofold. On one hand, it is in honour of an Englishman to whom the whole civilised world and the British Empire in particular owe a debt of gratitude, and it is intended to be a public recognition of his services while he is still among us, and a lasting memorial to him after his death. On the other hand, it is to enable Ross, a man of genius, assisted by other experts in medical science, to exercise his special gifts in the initiation and continuation of researches into the still unsolved problems of tropical medicine and hygiene. It is to be clearly understood that the Ross Clinique is intended to supplement and not compete with the existing schools of tropical medicine. Its aim is research alone, for which there is plenty of room in the great capital of the British Empire.

In its issue for June 19 the *Times* reported the great outbreak of lava on the north-eastern flank of Etna, which occurred on the early morning of Saturday, June 16, and was already causing widespread devastation. Further details, with a map, have appeared in later issues of the *Times*, together with a report by Prof. Ponte, who has ascended the slope as far as possible. As in so many previously recorded eruptions on the slopes of Etna, the lava has broken out from several mouths arranged along a fissure, which in this case is near the crater of 1879. At the time at which this note is written, it is early to speculate as to the extent to which the flow may spread, and the experiences of Catania on the southern side, often repeated in historic times, indicate the magnitude and the vitality of the great reservoir that has played so important a part in the physiography of Pleistocene times. Charles Lyell, from 1830 onwards, roused an interest in Etna as one of the most appealing examples of earth-structures reared by forces now in action. A detailed map, on which dates are inserted, such as that published by O. Silvestri in his "Viaggio all' Etna" in 1879, shows how, layer by layer, the vast composite mass continues to be built up and maintained. The neighbourhood has now been evacuated, and the scenes of flight depicted in d'Annunzio's amazing film "Cabiria" are repeated in the tragedy of to-day. Activity is also reported in the small cones that are growing within the crater of explosion formed in Vesuvius in 1906.

The memorial portrait of Alfred Russel Wallace was unveiled at the Natural History Museum and presented to the Trustees on June 23. Wallace was born in 1823 and died in 1913, so that the presentation has appropriately taken place in the centenary year of his birth. Shortly after his death a committee was formed to collect funds for the memorial, which was to take two forms, a tablet in Westminster Abbey and a portrait in the Natural History Museum. The first was completed and placed in position in 1914, but the latter was deferred owing to the War and was only recently finished. Sir James Marchant, in offering the portrait to the Trustees, gave a short account of the formation of the memorial committee, and concluded by asking Sir Charles S. Sherrington, President of the Royal Society, to unveil it. In his address the latter alluded to the fact that much of the fruit of Wallace's expedition in the Malay Archipelago is incorporated in the Museum collections, and dwelt upon the happy circumstance of the juxtaposition of Wallace's portrait and of Darwin's statue, two men whose discoveries at the same moment and on the same theme were placed before the scientific world. Prof. E. B. Poulton, a co-worker of Wallace, spoke of his life and work, and testified to the generosity of his character and to the unselfish enthusiasm with which he encouraged and assisted the work of others. The portrait was accepted on behalf of the Trustees by the Archbishop of Canterbury, who undertook that it should receive the care that the Museum accorded to its treasures. He remarked upon the interest which students felt at seeing what manner of men they were who had made such great advances in natural science. The portrait, which is an extremely good likeness, was painted by Mr. J. W. Beaufort from photographs.

A writer under the most appropriate pen-name of Æolus has recently contributed to the *Wimbledon Borough News* two lengthy letters of protest against the by-pass road that is planned to run alongside the ground recently added to Wimbledon Common on the further side of Beverley Brook. While we sympathise with his love of a Nature unspoiled by the dust, noise, and smell of motor cars, we cannot forget that this road is only part of a scheme settled years before the War, and already modified in this area to meet the views of those who obtained the extension of the Common. A further scheme, already mooted by the John Evelyn Club for Wimbledon, which might well receive support, is to fence off part of this tract as a Nature reservation. Wimbledon is singularly rich in birds, and it is even possible that some of our wild mammals may yet linger in the district. If the Common Conservators could see their way to provide a sanctuary for them they would earn the thanks of all lovers of Nature.

Captain R. Amundsen has abandoned his projected flight from Alaska across the Pole to Spitsbergen. The *Times* reports that an official communication to this effect has been issued by the Admiral commanding the Norwegian fleet. The statement is made that a trial flight on May 11 proved very unsatisfactory. In full expectation of the flight being attempted in the third week in June, the Norwegian Government had sent the *Farm* to Spitsbergen with supplies, and the transport *Flint*, carrying three seaplanes, arrived at King's Bay in the middle of June. The seaplanes were to patrol the edge of the polar pack to the north and north-west of Spitsbergen in order to render assistance to Captain Amundsen and his pilot, Lieut. O. Omdal, in the case of any enforced descent. It was proposed, if the distribution of the pack rendered it advisable, to deposit supplies of petrol and food on the ice, each marked with a conspicuous beacon.

"National Baby Week," which is to be observed on July 1-7 under the auspices of the National Baby Week Council, 117 Piccadilly, W.1, brings into prominence the many problems of infant mortality. These problems have two phases which seem dependent upon biological conditions: (1) the comparatively high death-rate in the first month of life, and (2) the comparatively high death-rate of male infants as compared with female infants. In the year 1921, the most recent for which detailed figures are available, there were 1051 male births for every 1000 female births, while the deaths of male infants occurred at the rate of 92·85 per 1000 births and female infants at 72·16 per 1000. During the first four weeks of life, the "neo-natal" period, the death-rate was 40·01 for males and 30·27 for females per 1000 births. These ratios stand with little variation year by year, though during and after the War the ratio of male to female births —as was expected on an empirical basis from historical records alone—was slightly higher than the normal (104 males to 100 females). It would seem that this greater susceptibility to the strains of environment is characteristic of the male sex. The neo-natal death-rate, which has yielded but little to those influences which have proved so effectual in lowering the infant mortality rate as a whole (from 154 per 1000 births in 1900 to 77 in 1922), constitutes another difficult problem in public health. An interesting recent investigation (by post-mortems) into the causes of death in sixty-two cases of neo-natal mortality showed that while 73 per cent. were due to conceivably preventable conditions, the remaining 27 per cent. were due to malformations—a finding which might seem to indicate that neo-natal mortality may be but the expression in human life of Nature's trial and error—a biological interpretation which would, however, tend to discourage infant welfare discussions on this subject in the forthcoming "National Baby Week."

In the current number of the *Poetry Review*, Mr. Oliver C. de C. Ellis has a lively and cheering article attacking the fallacy that there is any opposition between poetry and science. He might very well have gone further than he has. It would be truer to say that the highest gifts in poetry are closely akin to, or even identical with, those required for the highest achievements in science. Some of the greatest poets, Dante, for example, have been masters of the science of their time, and Wordsworth, in a famous passage in the preface to his second edition of the "Lyrical Ballads," looks forward to a time when modern science, having entered into the mental equipment of all cultivated men, will inspire a new order of poetry, as philosophy and rural lore inspired Lucretius and Virgil and medieval science inspired Dante. Both orders of mental effort depend, as Mr. Ellis says, upon the imagination, but whereas the man of science imagines laws and relations of things which may be verified and used for guidance as to their own future action, the poet sees them in their relation to the human soul. In this sense the work of the man of science is objective and stands on the order of events; the work of the poet is subjective or moral, and depends for its appreciation upon a state of mind attuned to his own. "Poetry," as Wordsworth tells us, "is the wealth and fine spirit of all knowledge"; "it is the impassioned expression which is in the countenance of all science." And, one must add, that whereas science aims at pure truth, poetry, having this emotional content, aims also at giving pleasure. It implies a certain form and a certain emotional effect, though the substance must also be truth. It is the "first and last of all knowledge."

The British Mycological Society is organising a phytopathological excursion to Wye, in Kent, on Saturday, July 7. Those intending to take part in the excursion should communicate with Capt. J. Ramsbottom, at the British Museum (Natural History), South Kensington, S.W.7, by Wednesday, July 4.

According to the *Chemiker Zeitung* for June, Dr. Paul Knoller, lecturer and assistant at the University of Freiburg (Switzerland), has been appointed professor of mineralogy and petrography at Dayton University, Ohio.

Owing to the increase in the work of the Rothamsted Experimental Station, it has been decided to appoint an assistant director, and Dr. B. A. Keen, head of the Physics Department, has been selected for this position.

A circular tablet of blue glazed ware bearing the inscription "James Clerk Maxwell (1831–1879), Physicist, lived here," has been affixed to 16 Palace Gardens Terrace, Kensington, where Clerk Maxwell resided for a time, by the London County Council. Maxwell's occupation of the house probably dated from the latter part of 1860, immediately after his appointment to King's College, or the early part of 1861. The first reference to it in his biography by Campbell and Garnett is in a letter dated May 21, 1861. He resigned his appointment as from Easter, 1865, and left the house for good in March 1866 (*ibid.* p. 260).

AT a meeting of the Royal Society of New South Wales on May 2, the following officers for 1923-24 were elected:—*President*: Mr. R. H. Cambage. *Vice-Presidents*: Prof. C. E. Fawsitt, Mr. J. Nangle, Mr. E. C. Andrews, and Mr. C. A. Sussmilch. *Hon. Treasurer*: Prof. H. G. Chapman. *Hon. Secretaries*: Prof. O. U. Vonwiller and Mr. G. A. Waterhouse. *Members of Council*: Dr. C. Anderson, Sir Edgeworth David, Mr. W. S. Dun, Dr. R. Greig-Smith, Mr. Charles Hedley, Rev. E. F. Pigot, Mr. W. Poole, Mr. H. G. Smith, Prof. J. Douglas Stewart, and Prof. R. D. Watt.

THE David Livingstone Centenary Medal for 1923 has been awarded to Dr. T. Griffith Taylor, associate professor of geography in the University of Sydney, Australia. This medal, founded by the Hispanic Society of America and awarded by the American Geographical Society, is given "for scientific achievement in the field of geography of the southern hemisphere." Dr. Taylor has made notable contributions to Australian geography, applying the results of his physiographic and climatic studies to problems of settlement and human adaptation. He is the author of several works on Australia and of numerous communications appearing in Australian Government bulletins, and was senior geologist and leader of the western parties on the British Antarctic Expedition of 1910–1913 (Scott's last expedition), on which he has written "With Scott: The Silver Lining" (1915). It is anticipated that the medal will be presented on the occasion of the Second Pan-Pacific Science Congress, which meets in August and September in Australia.

ON June 10 two departments were opened for the public and visitors in the new premises of the Geological Museum of the Petrograd Academy of Science. One of the departments is devoted to the general osteological collection and contains among its exhibits remains of Indricotherium, a giant primitive rhinoceros-like mammal, from the Turgai Oligocene deposits (Indricotherium beds), north of the Aral Sea, recently described by Prof. A. Borissiak (Mém. Acad. Petrograd (viii.) xxxv. No). The other department, the so-called North-Dvina gallery, is devoted exclusively to the Upper Permian fauna, discovered by Prof. Amalitzky, and contains his types, some of them partly re-developed and re-described by the present curator of the gallery, Prof. P. Sushkin (*Comptes rendus* of the Petrograd Academy for 1921 and 1922).

ONE of the main functions of the Fuel Research Board is a survey and classification of the coal seams in the various mining districts by means of chemical and physical tests in the laboratory, supplemented where desirable by large-scale tests at H.M. Fuel Research Station, East Greenwich, or elsewhere. It is considered that the best way to carry out this work is by means of local committees, the personnel of which would include colliery owners, managers, representatives of the Fuel Research Board and of the Geological Survey of Great Britain, as well as of outside scientific interests. In this way local knowledge and experience is made available. The first of these committees has now been actively at work in the Lancashire and Cheshire area for nearly eighteen months, and the Board has recently decided to deal with the South Yorkshire area. The South Yorkshire Coal Trade Association and the Midland Institute of Mining, Civil, and Mechanical Engineers are co-operating in the work. The following committee has been appointed: Dr. C. H. Lander (chairman, *pro tem.*), Mr. J. Brass, Mr. Robert Clive (hon. secretary), Mr. H. Danby, Lieut.-Col. H. Rhodes, Prof. R. V. Wheeler, and Dr. Walcot Gibson.

THE annual general meeting of the Research Defence Society, on June 20, when Lord Knutsford presided, was well attended, and the necessary business was quickly done. Dr. Saleeby lectured on "Sunlight and Disease"; and showed lantern-pictures and films illustrating the past and present use of "the sun-cure": especially the amazing results which Rollier has obtained at Leysin; the downright cure, by light alone, of many fearful cases of tuberculosis. If the photographs and the films had not been there, the whole thing would have been incredible. The sun, that careful doctor, had faithfully recorded the work which he had achieved. Dr. Saleeby also spoke of the experimental research which is being pursued into the action of light on life: the relation of light to the storage of phosphorus, calcium, and vitamin A in the body, and so on: but we are still a long way from understanding these mysteries. In Great Britain, a measure of success has been gained at Sir William Treloar's Hospitals at Alton and Hayling Island, and at Queen Mary's Hospital, Carshalton. But what is the good of talking of "sun-cure" in this country, in this weather? It was a sunless day, near the end of a sunless May and June. Besides, in our great industrial cities we poison the air with smoke. Dr. Saleeby's pictures of Manchester and Sheffield were Ruskin's prophecies come true. Prof. Dreyer is working for a better tuberculin-treatment. Mr. Justice McCardie has spoken his mind on the contagiosity of a dusty house in which a consumptive patient had lived. People are learning more about tuberculosis. But, until we get finer summers, use smokeless coal, and abolish slums and overcrowding, we must not expect to repeat the wonders of Leysin in Great Britain.

ON April 6 Mr. G. R. Clarke, the Director-General of Posts and Telegraphs for India, read a paper to the Royal Society of Arts on postal and telegraph work in India. He pointed out that the present problem is not the erection of more wires to carry the increased traffic, but to increase the capacity of the existing wires by the use of multiplex high-speed instruments. Automatic telephone exchanges have proved a great success at Simla and Lahore, and many similar installations are in course of erection. Radio communication has not proved successful in India owing to the "atmospherics" making signalling impossible at certain seasons.

The research department, however, has perfected methods of eliminating the disturbances due to this cause, and so it is hoped that the radio method will be much more widely adopted in the future. During the last year postal and telegraph communication has been established with Tibet and Afghanistan. The Dalai Lama has given every encouragement to the establishment of communication between Lhasa and India. Afghanistan has not yet joined the Universal Postal Union; letters are stamped to India, and a charge is made on delivery, but the amount of this charge seems to be uncertain. In the discussion on the paper Colonel Edwards said that India offered the most wonderful possibilities in the way of air mail transport. For example, the journey from Calcutta to Rangoon took at present 3-6 days. If an air mail service were employed the time taken would be only 9 hours. Many similar cases could be cited. In England difficulties are caused by fog, but in India the only fogs are the few that occur during the monsoon.

WE have received from the Department of Agriculture and Technical Instruction for Ireland a copy of the catalogue of maps, memoirs, and sections published by the Geological Survey of Ireland. The list includes maps, etc., for the whole of Ireland: they are now to be obtained from the Ordnance Survey Office, Dublin. The one-inch map for the whole country is available in 205 sheets. Of the 16 sheets of the quarter-inch map only four appear to be published. There is a recent six-inch map of Dublin and surroundings. These maps are colour printed.

Our Astronomical Column.

VARIATIONS IN THE SPECTRUM OF θ^2 ORIONIS.—M. F. Henroteau directs attention (*Comptes rendus*, April 30, p. 1210) to the spectrum of the star θ^2 Orionis, which is of magnitude 5·17 and situated in the nebula of Orion (R.A. $5^h\ 30^m{\cdot}5$, Dec. $-5°\ 29'$, 1900), being of the B-type spectrum. In 1904 Prof. E. B. Frost discovered the star to be a spectroscopic double with a radial velocity of 140 km. In 1919 and 1920 M. Henroteau found that in addition to the broad absorption lines of hydrogen and other elements, there were super-imposed on them thin bright lines which gave a velocity less than that accorded by Frost. To verify this, Otto Struve of the Yerkes Observatory obtained several spectrograms in 1922, but these showed no evidence of bright lines. However, another spectrogram on March 2 of the present year displays these sharp bright lines. Thus we have a B-type star, not known as a variable, which intermittently presents bright lines, a phenomenon very rare in occurrence. What adds great interest to this particular star is that it is situated in the nebulosity of Orion, and this situation may account for the peculiarity. M. Henroteau proposes to make a special study of its spectrum.

COLOURS AND SPECTRA OF DOUBLE STARS.—Till recently the course of a star's evolution was considered to be defined by the sequence represented by types O B A F G K M, and the fact that the fainter components of binaries are often bluer than the brighter components was a source of much perplexity. One of the results of the "Giant and Dwarf" hypothesis was to afford a simple explanation of the observed facts, since among giants the blue stage is later than the red; and, conversely, the observed phenomena afford another strong argument for that hypothesis. Mr. Peter Doig has traced the bearing of these facts in two papers during the past year; now Mr. F. C. Leonard returns to it in Lick Obs. Bull. No. 343. He has photographed the spectra of a number of close pairs with a one-prism spectrograph on the 36-inch refractor, finding it possible to get separate spectra even with pairs only 1″ apart; where the magnitudes differed the brighter star was occulted by a screen for part of the exposure. In order to classify the spectra he also took spectrograms of several typical stars with the same instrument, since he notes that slit spectrograms differ systematically from the objective-prism series used at Harvard.

The resulting spectral differences of the components of the binaries were then correlated with absolute magnitudes, and with differences of magnitude and mass, the facts being displayed in a series of diagrams; he classifies stars not fainter than 1.0 mag. (absolute) as giants, the remainder as dwarfs; it is clearly shown that among giants the primary is redder, among dwarfs bluer. Once this law has been established it enables us to make estimates of the absolute magnitudes of stars of undetermined parallax. Further, the difference of spectral type increases as a rule with increasing difference of absolute magnitude or of mass, and there is hope that, by tabulating these differences in as many cases as possible, a clue will be obtained as to the relative duration of the stages of development corresponding to the various spectral types; such information would be of much use in cosmogony. The research also affords a proof that the less massive stars pass through their stages more rapidly than the massive ones; this was indeed generally assumed, but it has been questioned.

The cases of Sirius and o^2 Eridani are noted as anomalous, the discordance in magnitude being much greater than we should expect from the disparity in mass; Mr. Leonard suggests that in the latter case the mass-ratio should be reinvestigated; that of Sirius cannot be much in error.

THE RADIAL VELOCITIES OF 1013 STARS.—Messrs. W. S. Adams and A. H. Jay contribute to the April number (vol. 57, No. 3) of the *Astrophysical Journal* a catalogue of radial velocities which includes many of the results obtained in this line of work at the Mount Wilson Observatory during the past few years. The list is composed almost wholly of stars with spectra of types F, G, K, and M which have been observed not only for radial velocity but also for determinations of absolute magnitude and spectroscopic parallax. The spectrograms have been obtained at the Cassegrain focus of the 60-inch and the 100-inch reflectors, and the latter instrument was employed chiefly for stars fainter than the eighth visual magnitude. Single prism spectrographs with prisms of 64° angle and cameras of 18-inch focal length were used. The faintest star photographed was of magnitude 9·9, and 10 to 15 stellar lines have been measured on each spectrogram, and a list of those most commonly employed is given in the paper. The results here collected have already been used to some extent by Strömberg, Seares, and the authors in investigations of space velocities and the relationship of velocity to absolute magnitude and mass, but their publication makes them now available to all.

Research Items.

Function of the Spleen.—More than ten years ago Richet showed that dogs from which the spleen had been removed had to eat more than normal animals to keep their weight constant. In the *Comptes rendus* of the Paris Academy of Sciences of April 16 he states that spleenless animals when starved lose weight more quickly than the controls, and concludes that the organ diminishes denutrition; its normal function, useful but not necessary to the economy, being to slow down metabolism. These observations may possibly be correlated with those of Korenchevsky (*Journ. Path. Bact.* vol. xxvi., 1923, p. 387), who describes hypertrophy and hyperplasia of the germ centres in the spleen in pigeons with beri-beri caused by an inadequate diet of polished rice—perhaps an attempt to compensate for the severe failure of nutrition.

Palæocene Primates of the United States.—More than ten years ago a considerable collection was made in the Sweet Grass County, Montana, of fossils from the Fort Union Palæocene. The intervening time has been devoted to the cleaning and preparation of these, among which the mammalian remains appear to represent at least forty species belonging to not less than fifteen families and six or seven orders. The descriptions of these will be undertaken, order by order, and ultimately combined into a single monograph. The Primates form the subject of a memoir by J. W. Gidley (Proc. U.S. Nat. Mus., vol. lxiii. art. 1). Until now true Primates have not been reported in America from beds older than the Eocene, and these indicated that earlier forms must have existed, so that it is not surprising, although of the greatest interest, that they do occur in the Fort Union Palæocene, and that all thence are in general of a more primitive type. These early Primates belong to two families: Tarsiidæ, represented by four genera, of which three—Paromomys, Palæchthon, and Elphidotarsius—are new; and Plesiadapidæ, with one new genus—Pronothodectes. No representative of the Notharctidæ appears in the Fort Union collection. The author discusses the affinities and relationships of these various forms. He concludes that the early tarsiids as at present understood do not represent a natural group. It would seem, however, that within this group are to be found the ancestral stock which gave rise to the living Tarsiers; and possibly also the ancestral form whence ultimately sprang the aberrant lemur—Daubentonia—of Madagascar. The root group, or beginning of the Primates as a distinct order, has still to be sought in yet older formations.

Eocene Pelecypoda of Burma.—The fauna of the Eocene of Burma is especially rich in Gastropoda, but contains a lesser proportion of Pelecypoda. The former were placed in the hands of the late Mr. Vredenburg for description, while Dr. G. de P. Cotter has dealt with the latter (*Pal. Ind.*, New Series, vol. vii., mem. 2). Twenty-five species are described and figured, of which nearly all are considered to be new. They indicate that the Yaw stage, to which the bulk belong, is to be correlated with the Upper Eocene of Java and the Bartonian of Borneo. The accompanying plates are remarkably good.

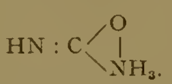
Soil Bacteria and Organic Antiseptics.—In an article in *Discovery* for June, Mr. P. H. Gray discusses the utilisation of organic antiseptics by bacteria of the soil. Phenol, cresol, toluene, and naphthalene applied to the soil disappear. This disappearance is due to the existence of bacteria in the soil which attack and destroy these compounds. Some 200 strains of antiseptic-decomposing bacteria have been obtained from over a wide area in Great Britain; they are able to grow in solutions containing the antiseptics and even to utilise these compounds as a source of energy. It is possible to increase the fertility of the soil by the addition thereto of a mild antiseptic. This destroys certain soil pests and disturbs the equilibrium between protozoa and bacteria in the soil, enabling the latter to increase, and the bacteria produce available plant food with an increase in fertility.

The Marine Element in the Fauna of the Ganges.—Dr. N. Annandale (reprint from Bijdragen tot de Dierkunde, K. Zool. Genootschap, Amsterdam, 1922, pp. 143-154) discusses the marine element in the fauna of the Ganges. He regards the Bay of Bengal, with its low salinity and gradual changes from salt water to fresh, as an exceptionally favourable starting-point for an immigration into fresh water on the part of marine organisms. An immigration of the kind has been in progress for a long period, and many adaptable euryhaline species are still attempting to establish themselves above the limits of tidal influence in fresh water. A very slight change either in the environment or in the constitution of the animals themselves would enable them to do so. The relict and euryhaline faunas of the Ganges represent different stages in this process of inland immigration, which has proved successful owing to the vigorous constitution of those organisms that have missed no accidental opportunity of establishing themselves in fresh water. In spite of superficial changes, a large proportion of both the relict and the euryhaline forms are of essentially primitive structure, or at any rate belong to ancient groups some of which have almost or completely disappeared from adjacent seas. In other words, fresh and brackish water have proved a last refuge for many marine species whose race in the sea was nearly done.

The Non-Mendelian Inheritance of Size Characters in Flower Petals.—Prof. R. R. Gates describes, in the *Journal of Genetics*, vol. 13, No. 1, March, the inheritance of petal size through four generations of reciprocal crosses between *Œnothera rubicalyx* and *Œ. biennis*. A more or less uniform F_1 generation is followed by wide segregation in F_2, not only between the size of petals in different plants, but even on the same plant and in some cases on the same flower. A close analysis of these flowers does not suggest frequency curves grouped around modes dependent upon different size factors, but rather haphazard distribution of sizes due to the failure of adjustment between different size tendencies inherited from the original cross. Such variation in size does not appear apart from the original cross, so that germinal factors are involved, but their representation is not possible, either in terms of normal Mendelian factors or in terms of the Galtonian curve for fluctuating variability. Prof. Gates suggests that the variable nature of these inherited tendencies, as exhibited within the individual, may arise through their partial dependence upon cytoplasmic characters of the parental forms.

The Oil Palm under Cultivation.—The oil palm, *Elæis guineensis*, occurs naturally in West Africa over an area lying between 12° N. and 12° S. of the equator. The fruit of the palm has an outer pulpy coat which contains some 50 per cent. oil and an inner kernel with about the same percentage of an oil of different composition. Both these oils are of commercial value, and G. G. Auchinleck, in Bulletin No. 62 of the Department of Agriculture, Ceylon, estimates that 300,000 tons of kernels and 100,000 tons of palm oil come on to the market annually. The French, English, and Belgians are in control in the various oil-producing areas of Africa, but the Dutch appear to be first in definitely undertaking the systematic plantation of the oil palm, some 28,000 acres being planted with this plant in Sumatra by 1922. If the somewhat uneven product and irregular supply from the palm's natural habitat can be replaced by a trustworthy product developed from a systematic plantation industry, the African palm-oil trade will meet with a formidable competitor. British planters in the East would probably do well to study Mr. Auchinleck's account of the oil palm and its product in this bulletin, and to watch the future history of the oil palms now planted at the Anuradhapura Experiment Station in Ceylon.

UREASE.—A powerful enzyme, which has the property of causing the rapid conversion of urea into ammonium carbonate, has been found in many plant tissues, especially seeds. That of the soya bean is the best known. Dr. W. R. Fearon, in the *Biochemical Journal* (vol. 17, No. 1, 1923), shows that what urease does is to split urea into cyanic acid and ammonia. He has isolated cyanic acid from solutions of urea under the action of the enzyme. The enzyme has no other action; cyanic acid in the presence of water rapidly undergoes spontaneous hydrolysis into carbon dioxide and ammonia. The facts can only be satisfactorily explained on the cyclic formula for urea put forward by Werner; that is,



The decomposition of urea by acids, alkalies, or heat proceeds along the same lines. We see also why urease does not decompose ethyl-urea or methyl-urea, not because of the nature of the enzyme, but because these substances do not yield cyanic acid.

VALENCY OF BORON.—We have received from the Koninklije Akademie van Wetenschappen te Amsterdam a reprint of an interesting paper on "The Valency of Boron," by Prof. J. Böeseken, from the point of view of atomic structure. He concludes that boron exhibits valencies of 3 and 5.

SEPARATION OF THE ISOTOPES OF MERCURY.—A detailed account of the partial separation of the isotopes of mercury by evaporation in vacuum in a large steel apparatus is given by Harkins and Madorsky in the March issue of the Journal of the American Chemical Society. The atomic weights of the heavy and light fractions differ by 0·1 unit. The partial separation is still a long and somewhat laborious process, but the authors state that they have designed an apparatus which would give the same separation in about thirty hours. The heavy and light fractions are still mixtures of isotopes, six of which, according to Aston, exist in the case of mercury.

WEATHER AT HONGKONG DURING 1922.—The *Monthly Meteorological Bulletin* for December 1922 contains "detailed results of observations made at the Royal Observatory, Hongkong, and the daily weather reports from various stations in the Far East," prepared under the direction of Mr. T. F. Claxton. The part for December also contains an annual summary of the Hongkong observations for the year 1922 and gives the mean and extreme values of the principal meteorological elements, with the normal values for the period 1884–1918. Tracks of the typhoons and principal depressions which occurred in the Far East during the year 1922 are shown on two plates. At Hongkong the barometric pressure during 1922 ranged from 30·445 in. during November to 29·174 in. during August. The air temperature ranged from 93·1° F. in August to 43·7° F. in November. The monthly mean was highest in July and lowest in January, the mean temperature for the two months differing by 22° F. For the thirty-five years the highest temperature observed was 97·0° F. in August 1900, the lowest 32·0° F. in January 1893. The total rainfall in 1922 was 69·44 in., of which 17·54 in. fell in August, and rain fell on 154 days. The average total rainfall for the thirty-five years is 83·83 in., the average total rain in the four months May to August being 55·13 in. The greatest prevalence of wind is from the east. Values of magnetic elements are given for the year; the means were Declination (west) 0° 21′·5, Dip (north) 30° 46′·0, Horizontal Force (C.G.S. Unit) 0·37279, Vertical Force (C.G.S. Unit) 0·22194, Total Force (C.G.S. Unit) 0·43386. No mention is made on the title-page of the Bulletin that the results for the year and the cyclone tracks, as well as the averages for thirty-five years, are given, and a casual reader might overlook this information, which is of primary importance.

EGYPTIAN PETROLEUM.—Heavy-grade Egyptian crude petroleum formed the subject of a paper by Mr. W. A. Guthrie read recently at the Institute of Petroleum Technologists. The oil chiefly discussed was the product of the well-known Hurghada (Rargada) wells, situated about 200 miles S.E. of Suez, on the western shore of the Gulf. This field was first developed in 1914, since when it has produced 1,201,868 metric tons of oil; its present output averages 3500 tons per week. Some proportion of the oil contains salt water up to 30 per cent., an emulsion which, though it has proved refractory to deal with, seems to respond to electrical dehydration treatment, a method not always commercially possible. The dry oil flashes below 45° F., and its s.g. ranges from 0·907 to 0·925. Its sulphur content varies from 0·5 per cent. to 2·22 per cent. (comparatively low), while it yields 10-11 per cent. asphalt and 7-8 per cent paraffin wax: hence it may be classed as a true mixed-base oil. Distilled in the ordinary way, the crude oil gives 8 per cent. benzine and 15 per cent. kerosene, the residue (above 290° C.) constituting 76 per cent. Both the benzine and kerosene can be refined to very high-grade products, while the residue is utilised for the production of solar or Diesel oil (43·2 per cent.), hard pitch (29·3 per cent.), and inferior fuel-oil. The inclusion of an appreciable quantity of paraffin wax in the pitch is considered by the author to be advantageous rather than deleterious to its use for road surfaces, since theoretically it should enhance chemical stability and render the material less liable to crumble or disintegrate under climatic variations or under ordinary wear and tear. The author dealt at some length with paraffin wax extraction, by no means an easy problem in this case, but this product actually finds little use within Egypt itself. One other interesting point mentioned in the paper was in connexion with the oil produced from the new field at Abu Durba, on the east shore of the Gulf; chemical and physical tests apparently show that this oil is an inspissated and oxygenated product of petroleum: it is of a very heavy asphaltic character and contains varying proportions of a waxy resin.

Museum Building at South Kensington.

THE latest chapter in the long history of museum building at South Kensington opened in 1909 when a large deputation of those interested in science and industry presented to the president of the Board of Education a memorial urging that the time had come for action with the view of providing proper housing for the Science Collections at South Kensington. The memorial, and the speakers who supported it personally, focussed the opinions of all the leading scientific and technical societies and institutions. Acting on the representations then made to him, the president of the Board of Education appointed in 1910 a "Departmental Committee on the Science Museum and the Geological Museum," with Sir Hugh Bell as Chairman. Three years later, the adoption of the report of that committee appeared to secure the early provision of adequate facilities for a well-directed advance in the usefulness of these museums.

Building operations were duly commenced, but were interrupted during the war period. Resumed later, they have made so little progress that representatives of the societies which originated the movement in 1909 have recently had occasion to consider the present position and to make a representation with regard to it. As the matter is one of wide interest, the following summary of its salient features may be of interest to those who are not familiar with the published papers that bear upon it.

THE SCIENCE MUSEUM.

For forty years the Science Collections have been developing on consistent lines. For more than twenty years they have been recognised as being, among national collections of the same field, the best museum collections in the world, but as having the meanest of museum buildings. It is now thirteen years since the appointment of Sir Hugh Bell's committee—a strong departmental committee of men versed in pure and applied science. That committee took careful measure of the possibilities and of the needs of the Science Museum, and formulated a well-considered and clear report upon the whole matter (Report, 1911, and Report, Part II., 1912).[1] This report received warm approval at all hands, and it was adopted by the Government as the basis for the development of the Museum. The first requirement to be met was necessarily the erection of adequate and worthy building accommodation.

In its report the committee quoted the exhibition space available in 1911 as 98,000 sq. ft. (94,000 sq. ft. in old buildings and 4000 sq. ft. in the new Western Hall), and said that buildings twice as large would be required for the then existing collections without the addition of a single specimen. The committee estimated at 265,000 sq. ft. the total exhibition space then required in new buildings, and recommended the provision of a building to occupy the ground available on the existing site, as shown on the accompanying plan (Fig. 1), this building to be erected in three successive sections, the eastern, the central, and the western blocks. The committee reported that the central as well as the eastern block would be required for the more immediate needs of the Museum.

In the programme for the replacement of the old buildings by a continuous building occupying the whole of the Science Museum site from Exhibition Road to Queen's Gate, three periods in the process are distinguished. The *first period* covers the erection of the eastern block; this is the present period. In the *second period*, when the new central block will be in process of erection on ground cleared by the demolition of the main part of the existing old buildings, the eastern block of the new building with the existing western galleries and western hall "will afford opportunity for exhibiting the collections made during the first period and for working up the

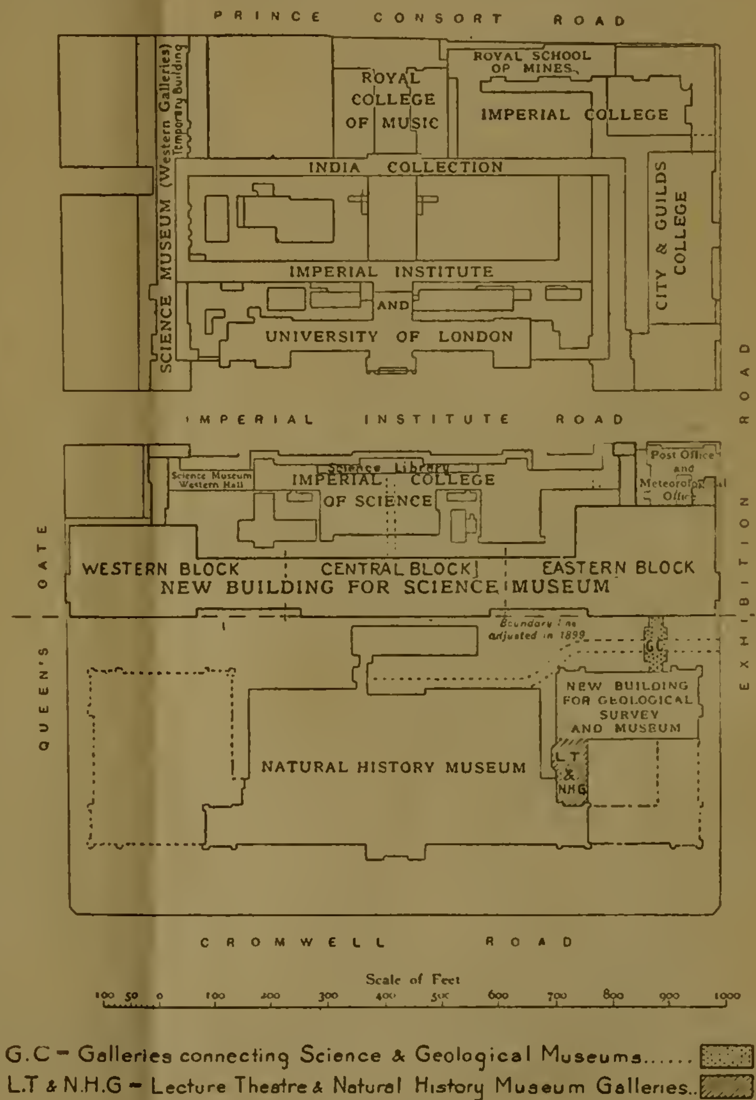


FIG. 1.

[1] Report of the Departmental Committee on the Science Museum and the Geological Museum, 1911, Cd. 5625; (Part II.) 1912, Cd. 6221.

collections in all departments." The close of the second period will see both the eastern and central blocks of the new building fully available for the uses of the Museum and for the development of its collections. The committee contemplated a pause in the building operations at this stage. It said that during the *third period*, which will last till the western block is built, "the new eastern and central blocks with the existing western galleries, will afford a total accommodation that may be expected to suffice for all requirements until there is a clear call for the western block."

The first section of the new building—the eastern block—was commenced in 1913. Then came the War: the shell of the building was put to other uses and continued to be so appropriated for some years after peace was declared. Building operations have now, however, been resumed on part of the block, and this first instalment of the new permanent quarters for the collections is expected to be completed by the end of 1924. It will provide, say, 75,000 sq. ft. of new exhibition space—only one half of the total set-out for the complete eastern block of the "Bell" report. Moreover, it appears to be contemplated that the existing Western Galleries, in which are housed the collections illustrating mathematics, astronomy, physiography, meteorology, physics (part), chemistry, metallurgy and mining, will be vacated about the end of the present year to make room for part of the War Museum collections.

The Western Galleries provide 33,000 sq. ft. of exhibition space, and as a part of the old building which provided 20,000 sq. ft. had to be demolished in 1913 to make way for the new eastern block, the total of the *old* exhibition space available in 1925 will be 53,000 sq. ft. less than that in use in 1911. The *new* space to be added in 1924 by part of the eastern block is 75,000 sq. ft., so that the net increase in 1925 as compared with 1911 will be only 22,000 sq. ft. Meanwhile, quite apart from additions to other sections, accommodation has had to be found for the two important new sections which illustrate respectively aviation and wireless telegraphy and telephony, and these alone already occupy more than 12,000 sq. ft.

For all practical purposes, on the programme as now understood, the Science Museum will be in 1925 no better off in the matter of exhibition space than it was in 1911: that is to say, it will be still so grossly overcrowded that the collections cannot possibly be examined in the way museum objects ought to be. In these circumstances the obvious practical step is to put in hand for completion not, as now, merely one half of the eastern block, but the whole of the block that is not at present in temporary occupation by the Museum. Better still would it be to provide other temporary accommodation for the sections of the collections there exhibited and to proceed with the completion of the whole block.

Indeed, there must be certainty of active and continuous progress with the building scheme as a whole, for not until the central as well as the eastern block is completed will the Science Museum have any appreciable increase of space for its steadily growing collections. Yet it is doubtful if there ever was a time when the progress of science and invention required so much of museum exhibition or when the Museum could do so much to spread intelligent appreciation of the achievements of science and of its applications in industry.

THE MUSEUM OF PRACTICAL GEOLOGY.

The terms of reference to Sir Hugh Bell's committee required the committee to consider and report upon the Geological Museum in Jermyn Street, as well as upon the Science Museum. On each it was to advise as to the purposes the collections should serve, the lines upon which they should be developed, and "as to the special characteristics which should be possessed by the new buildings which it is hoped will shortly be erected on the South Kensington site to house these collections."

As in the case of the Science Museum, so in that of the Geological Museum, the report with its appendices gives clear recommendations on these points. The committee shows the need for a larger building than the Jermyn Street site provides, and urges the advantages of bringing the Geological Museum into due relation with other museums at South Kensington. Yet ground has not been broken for a new Geological Museum building.

Now those passages in the report which deal with the Geological Museum are particularly helpful and hopeful, for it is evident that the committee gave special consideration to points affecting the co-ordination of the several national museums that are concerned with science, and that it saw the way to an effective and economical scheme by which, while each museum would preserve its individuality and its autonomy, its own organisation and responsible authority, all three—the Natural History Museum, the Museum of Practical Geology, and the Science Museum—might be grouped and worked so as to form jointly a complete and worthy national museum of science. The accomplishment of this ideal would be warmly welcomed by all workers in science no less than by students and the public at large.

The committee reported that the Geological Survey Offices and Library and the Museum of Practical Geology were cramped by the limitations of the building in Jermyn Street, and that if the necessary space could be allotted at South Kensington it would be of great advantage to have a building giving the required accommodation erected as part of the general scheme there. The committee pointed out that collections in the Science Museums represent the general principles of geology and geography by examples selected from all parts of the world, while the economic collections in the Museum of Practical Geology in Jermyn Street are arranged with special reference to the needs of the practical man and the technological student, and its stratigraphical collections deal specially with the geology of the British Isles. The committee added that if all these were housed in new buildings at South Kensington in communication with the systematic collection of minerals, and the palæontological collections arranged according to their natural affinities in the British Museum (Natural History), the series would represent at a single centre the whole field of geological science.

The committee further reported that the Trustees of the British Museum were willing that the building for the Museum of Practical Geology and the Offices and Library of the Geological Survey should be placed on the part of the site allotted to the Natural History Museum. The scheme provides that this building be erected in connexion with and as part, structurally, of the eastern extension of the Natural History Museum, when it comes to be built, and that it be brought into direct communication on its north side with the new Science Museum building by connecting galleries carried over the roadway which gives access to the back of the Natural History Museum. (See Fig. 1.)

The sketch plan submitted with the committee's report shows the new building for the Museum of Practical Geology and the Offices and Library of the Survey as a self-contained unit. This unit, however, communicates on the north with the Science Museum and its collections illustrating physical geology, physiography and geography, mining, metallurgy, and construction, while to the south it is in direct connexion with the mineral and palæontological collections of the Natural History Museum. The plan also shows in the related part of the Natural History Museum the position of a lecture room which the authorities of that Museum contemplate for joint use in connexion with their own Museum and with the Museum of Practical Geology.

There is no need to detail the many advantages of this scheme. They are obvious. It should be noted, however, that the limitations of space in the Jermyn Street building are no less harmful now than they were ten years ago. On the other hand, in the case of the geological section of the new buildings at South Kensington, financial considerations should not now present much difficulty, for the value of the Jermyn Street site would go far to balance the cost of providing the larger new building on the site designated for it.

It is worth while to quote here the concluding section of the 1911 Report of Sir Hugh Bell's committee:

"In other departments of knowledge, the British Museum and the Victoria and Albert Museum have set a high standard for the national provision of Museum facilities. In the domain of Science the requirements of most of the branches of Natural History are already admirably provided for at South Kensington in the Natural History Museum. In no way overlapping or duplicating the functions of these great institutions, but representing aspects of human activity which lie outside their scope, not less ample provision is necessary for those departments of knowledge, invention and discovery, the needs of which have been brought so vividly before us in our inquiry; and we are of opinion that no scheme for a national Science Museum can be regarded as satisfactory unless it provides the buildings necessary for affording to Science and the industries all the assistance a Museum can give. A Science Museum in which all branches of Physical Science, Pure and Applied, and the Scientific and Economic work of the Geological Survey shall be adequately illustrated in close proximity to the other great Museums at South Kensington will, we believe, be of incalculable benefit alike to intellectual progress and to industrial development, and will be recognised as an institution of which the country may well be proud."

Antarctic Geophysics.

THE two reports referred to below[1] are the records of the aurora observations and gravity determinations made during Capt. Scott's last south polar expedition, 1910–1913. They are both dated for 1921, but it was only in February of this year that they reached us.

The original plans for auroral observations on Capt. Scott's *Terra Nova* expedition included photographic determinations of the height of auroræ, using Prof. Störmer's method. This part of the programme unfortunately proved impossible to execute, owing to the lack of the necessary special lenses and photographic plates. The auroral spectrum also was not observed, so that the work accomplished consisted of visual observations, namely, sketches, brief descriptions, and times of occurrence of auroræ. These data are now summarised and discussed by Mr. C. S. Wright, himself a member of the scientific party. The sketches and daily log are not reproduced, but the plan of observation and the resulting data are described in general terms, discussed statistically, and finally considered in their theoretical bearing.

Observations were made at two stations, in what may be termed the Scott-Shackleton strip of the Antarctic coast. One was Cape Evans, 77·6° S., 166° E., and the other was Cape Adare, 71·3° S., 170° E. Both stations are thus within a few degrees of the south magnetic pole, but considerably farther from the pole of the earth's magnetic axis, Cape Adare being at the greater distance. The two stations are about 700 kilometres apart, and a horizontal plane through one station would, in consequence of the earth's curvature, pass over the other at a height of about 40 kilometres. Auroræ occur at heights of about 90 kilometres and upwards above the earth's surface, so that from either station, in clear weather, auroræ above, or even a little beyond, the other, would be visible low down on the horizon. The hills and mountains in the neighbourhood of Cape Evans obscure the free horizon in some directions, though the report does not indicate which these are, nor whether Cape Adare is similarly affected. This information, together with more detailed statistics as to the relative frequency of auroræ at different altitudes, would have added to the value of the report.

In many respects the auroral features at the two stations are strikingly dissimilar. Auroræ are far more frequent at Cape Adare than at Cape Evans, and also more distinguished by brilliance, colour, and motion. Cape Adare is therefore nearer to the region or belt of maximum auroral frequency than Cape Evans is. Moreover, the majority of auroræ visible from Cape Adare lie to the north, so that Cape Adare, and *a fortiori* Cape Evans, is situated within the belt. This has an interesting bearing on the size of the auroral belts; the Arctic auroral zone is generally supposed to have a radius of about 20°, and to be centred at the pole of the earth's magnetic axis. There is no very recent determination of the position of the pole, but it can scarcely have moved more than a degree or two from its position in 1885, the epoch of Adams's investigation. Cape Adare is 27° distant from this point, and as this angle is a lower limit for the radius of the belt, this radius would seem to be greater than was to be expected.

The auroræ visible from Cape Adare, since they lie to the north, must for the most part be less than 3° above the horizon of Cape Evans. Consequently the auroræ seen from the latter station must in the main be different from the former. They represent conditions some degrees within the belt, and they differ in number and brilliance from those near the belt. They appear most frequently in a direction slightly north of east, and least often in the west. Again, whereas the Cape Adare auroræ trend predominantly east and west, or rather from a little north of west to a little south of east, the Cape Evans auroræ show a marked avoidance of the east-west trend. In each case the trend is perpendicular to the direction in which auroræ are least frequently seen. Brightly coloured and quickly moving auroræ are rare at Cape Evans, but fairly common at Cape Adare.

Auroræ were seen at Cape Evans on about one day out of three when seeing conditions were favourable, and about twice as often at Cape Adare. At either station they usually appear first at a low altitude in the direction of maximum frequency, and move

[1] British (*Terra Nova*) Antarctic Expedition, 1910–1913. Observations on the Aurora. By C. S. Wright. (Published for the Committee of the Captain Scott Antarctic Fund.) Pp. viii+48. (London: Harrison and Sons, Ltd., 1921.) 7s. 6*d*. net.

upwards, approaching the station, sometimes passing overhead and, after an interval, vanishing while in the region of minimum frequency. The overhead passage was much more common at Cape Adare than at Cape Evans.

The auroræ show a well-marked tendency to occur most often in the early morning, round about 4 A.M. local time. A secondary maximum occurs at Cape Adare at 8 P.M., and a trace of it is apparent also at Cape Evans. In the afternoon the auroræ rarely pass overhead, but they are more often brilliantly coloured and of swift motion than those which occur in the morning. At times of maximum frequency the aurora is also generally of greatest extent.

In the magnetic report of the expedition, by Dr. Chree, the connexion between magnetic activity and the aurora has already been discussed; Mr. Wright here carries the discussion further. It is clear that there is some relation between the two phenomena, though it is not so evident as in latitudes farther from the pole, where auroræ are seen only rarely, and are always accompanied by magnetic storms. Mr. Wright shows, however, that there is a marked correspondence between the magnetic character of a period of several hours about the time of appearance of a brilliant aurora, and the intensity of the aurora; the relationship is much more close than that between the same two characteristics at individual hours. Some of the results of this report had been anticipated by Mawson's report (1908) on the auroral work of the Shackleton expedition, though the latter is not confirmed in all respects. The auroral station in the Shackleton expedition was not far from Cape Evans.

These valuable memoirs will become of still greater significance and importance if and when another south polar expedition conducts similar observations in a part of the Antarctic considerably different in longitude from the Scott-Shackleton region, but at a similar distance from the pole of the earth's magnetic axis.

Mr. C. S. Wright's report [2] on the gravity observations, for which he was responsible, made during the *Terra Nova* expedition, is a record of a most manful struggle against difficulties. It seems very regrettable that the instrumental equipment of the expedition was not of the highest quality, for observations in the Antarctic are sufficiently exacting even under the best conditions. As a matter of fact, some of the equipment for Mr. Wright's gravity work was very bad, particularly the old transit circle on which he had to rely for his clock rates.

Four series of observations were made at Cape Evans, the first two being made in a cave cut in snow-drift consolidated to ice. The cave being small, the temperature varied by 10° C. during the time of observation, due to the observer's presence; all the mirror and lens surfaces were frosted by his breath, and also the prisms, agate planes, and pendulums themselves. A fortnight's break in the series of observations for each determination of g was made in order to allow the mirrors to clear. Notwithstanding all the efforts made to meet these conditions, the first two series gave such discordant results that in the second year a change was decided upon.

Attempts were made to build a small observing hut of (full) petrol cases covered with rubberoid and canvas; the hut was to be heated artificially during the observations. Twice the nearly completed hut was demolished by blizzards, and when at last it was securely built and banked with snow, it had to be abandoned after some days' trial, as it was found impossible to maintain it at a workable temperature, or even to keep it free from drift snow. Finally, the photographic dark-room opening off the living hut was lent as an observing station. Two series of observations were made here, in July and August 1912; the last series was not so good as that made in July, probably owing to the whole hut being shaken by blizzards during the August determination. Rejecting the results obtained in the previous year, the mean value of g from the three pendulums used in 1912 at Cape Evans was 983·003 from the July series and 983·004 from the August series: the probable error of the final mean is given as 0·0023 cm./sec.^{2}. Commdr. Bernacchi, who on Scott's earlier expedition was faced with even greater difficulties in some respects, obtained the values 982·970, 982·979, and 983·025 from his three pendulums, at a spot fifteen miles farther south. These values may be compared with the standard value 981·292 at Potsdam, which was taken as the reference or base station for the gravity work, and where Mr. Wright received training and much help from Prof. Helmert and his staff at the Geodetic Institute.

Observations were also made at Wellington, Melbourne, and Christchurch, in the latter case both on the outward and return journey. The value of g had already been accurately observed at Melbourne by Hecker in 1904 and Alessio in 1905, who obtained accordant values 980·003; the value found by Mr. Wright was 980·009, the difference exceeding the sum of the probable errors in the two cases: no reason for the disagreement can be assigned. The observations at Christchurch, like those made there earlier by Bernacchi, were unfortunately not very successful or accordant. The observation at Wellington was the first that had been attempted there. The check observation at Potsdam at the end of the expedition agreed well with the initial determination made with the same pendulums.

[2] British (*Terra Nova*) Antarctic Expedition, 1910–1913. Determinations of Gravity. By C. S. Wright. (Published for the Committee of the Captain Scott Antarctic Fund.) Pp. 106+4 plates. (London: Harrison and Sons, Ltd., 1921.) 7*s*. 6*d*. net.

Industrial Fatigue Research.

THE third annual report of the Industrial Fatigue Research Board (H.M. Stationery Office, price 2*s*. net) is even more interesting than those which have preceded it. It contains not only an account of the constitution, organisation, investigations, researches, external relations, and publications of the Board, but also nearly fifty pages of original contributions from five of its investigators—Mr. Farmer, Miss May Smith, Mr. Wyatt, Dr. Vernon, and Mr. Weston.

During its three years of activity the Board has published twenty-three reports—seven on general industrial problems, seven on the textile industries, five on the metal industries, two on the boot and shoe industry, one on the pottery industry, and one on the laundry trade. "More recently, however, and pending development of some scheme of actual co-operation with industries . . . the Board have tended to modify their original procedure, and have taken as their objective the study of certain general subjects, not confined to any one industry but of common interest to all, following up each subject along lines which experience shows to be most promising and dealing with it both by field investigation and by laboratory research."

The scientific committees under the Board accordingly comprise those for industrial health statistics, physiology of muscular work, physiology of the respiratory and the cardio-vascular systems, and industrial psychology. In addition to its five industrial committees, dealing respectively with the textile, metal, pottery and glass industries, and with industries specially affecting women, the Board has appointed two special committees, one concerned with Post Office work (more particularly the study of telegraphists' cramp), the other with Legibility of Type, in accordance with the recommendation of a committee "appointed by a Treasury Minute to select the best faces of type and modes of display for Government publication."

In this short notice it is impossible to do more than quote the titles of the interesting essays contributed to the report by the Board's Investigators; they are—"Some Considerations concerning Technique," "The Use of the Sample in Investigation," "Some Observations on Industrial Conditions, with Special Reference to Cotton Weaving," "Atmospheric Conditions and Industrial Efficiency," "Future Investigations in the Pottery Industry," "A Note on Machine Design in Relation to the Operative."

British University Statistics, 1921–22.[1]

THE most noticeable feature of the University Grants Committee's new blue-book is that it contains only 20 pages, whereas the returns for 1920–21 covered 391. The Committee proposes to issue a fuller publication on the old lines from time to time, say once in five years. In the intervals the public will be the more dependent for information on the Universities Yearbook. Oxford and Cambridge are not yet included in the returns, as their grants were "special emergency" and not regular grants. Excluding ex-Service students (8000 in 1921–22; 11,512 in 1920–21) the returns show, compared with those for the preceding year, increases of 2234, or 14 per cent., in the number of full-time men students, and 699, or 7 per cent., in the number of women students. The Committee points out that the numbers in England and Wales are about double what they were in 1913–14, and that the comparative smallness of the increase in Scotland (35 per cent.) was "no doubt due to the fact that the war found what may be called the 'university habit' already firmly established there by long tradition, assisted since 1901 by the operations of the Carnegie Trust."

Of the total number of full-time students, 93 per cent. had their homes within the United Kingdom, 58 per cent. within 30 miles from the university or college; of the remainder, 5 per cent. came from other parts of the Empire and 2 per cent. from foreign countries. Students from parts of the Empire outside the United Kingdom constituted 8 per cent. of the full-time students in London and 7 per cent. of those in Scottish institutions. Of full-time men students 6 per cent., and of women 28½ per cent., lived in Halls of Residence. The percentages of students in Halls of Residence in London, other parts of England, Wales, and Scotland were 11, 18, 23, and 5 respectively. Full-time students admitted for the first time in 1921–22 numbered 9249, including 3421 women; 52 per cent. were not less than 19 years of age, 28 per cent. were not less than 18, and 2⅔ per cent. were less than 17.

Three-fourths of the full-time students were following courses leading to first degrees, and 4½ per cent. were engaged in post-graduate study or research. Part-time students numbered 14,462, of whom 9455 were occasional students, 1126 were preparing for first degrees, and 2008 were graduate students or research workers. In addition there were 14,345 students taking courses not of a university standard.

Full-time students of medicine, including dentistry, numbered 11,612 (women, 2595)—nearly 32 per cent. of the total; 33 per cent. (men 5805, women 6252) were enrolled in faculties of arts, theology, law, music, commerce, economics and education; 2½ per cent. (men 758, women 123) were engaged in the study of agriculture, forestry, horticulture and dairying; and the remainder were equally divided between pure science (men 4295, women 1851) and technology (men 6019, women 68).

The number of first degrees obtained was 6352, including 2573 honours degrees; the number of higher degrees, 843.

The statistics of income were summarised and commented on in the article published in NATURE of May 26 on the Universities Conference. Of the expenditure (3,565,375*l.*), 10 per cent. was for administration, 49·3 per cent. for salaries of teaching staff, 13·4 per cent. for other expenses of departmental maintenance, 13·1 for maintenance of premises. Of income, 10·3 per cent. was from endowments, 2·7 per cent. from donations and subscriptions, 35·3 per cent. from parliamentary grants, 35·7 from tuition and examination fees. Recurrent grants from the Treasury amounted to 1,070,082*l.*, non-recurrent to 271,250*l.*, in addition to which there were special grants amounting to 499,400*l.* to provide retrospective superannuation benefit.

FULL-TIME STUDENTS IN VARIOUS FACULTIES IN 1913–14 AND IN 1921–22.

	London.	England, including London.	Wales.	Scotland.
All faculties—				
1913–14	3,874	10,023	1,230	8,419
*1921–22	7,208	20,065	2,712	..
1921–22	9,380	22,524	2,850	11,409
Pure Science—				
1913–14	441	1,620	234	655
*1921–22	1,177	3,925	721	..
1921–22	1,685	4,433	767	946
Medicine, including dentistry—				
1913–14	2,011	3,226	42	2,283
*1921–22	3,326	6,462	254	..
1921–22	3,943	7,079	260	4,273
Technology—				
1913–14	290	1,544	78	1,051
*1921–22	562	3,433	176	..
1921–22	†1,280	4,151	226	‡1,710
Agriculture, etc.—				
1913–14	..	221	58	140
*1921–22	..	298	110	..
1921–22	..	‖298	110	473

* Excluding the institutions which, not being then in receipt of grants, were not shown in the returns for 1913–14.
† Including 718 in Imperial College, South Kensington.
‡ Including 649 in the University of Glasgow and 707 in the Royal Technical College, Glasgow.
‖ Including 62 at Armstrong College, Newcastle-upon-Tyne, 60 at the University of Leeds, and 176 (82 women) at University College, Reading.

University and Educational Intelligence.

ABERDEEN.—For a number of years the hospital accommodation of Aberdeen has been insufficient, and the city has now before it a bold and comprehensive plan for remedying this defect. Originating with the Aberdeen Medico-Chirurgical Society some three years ago, the scheme has been elaborated by a committee

[1] University Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant, 1921–1922. Pp. 20. (London: H.M. Stationery Office, 1923.) 3s. 6d. net.

representative of the various bodies concerned, including the directors of the Royal Infirmary, the directors of the Royal Hospital for Sick Children, and the University. It is proposed to utilise a site of more than 110 acres on the Town Council's properties of Burnside and Foresterhill, on the north-western outskirts of the city. The University on its part would build departments of medicine, surgery, midwifery, pathology, bacteriology, and pharmacology, with adjoining students' hostels. The teaching of these subjects would be removed from Marischal College, and the latter part of the medical course would be passed in immediate touch with the wards. The scheme has been in existence for about three years, but has not been pressed. The other bodies concerned having expressed their readiness to proceed, the matter is now before the Town Council. The difficulties in the way of the scheme are chiefly financial, a sum of about three-quarters of a million being involved. The advantages to the public served by the hospitals and to the teaching of medicine in the north of Scotland are incalculable.

CAMBRIDGE.—Dr. A. B. Appleton, Downing College, Mr. D. G. Reid, Trinity College, Mr. A. Hopkinson, Emmanuel College, and Mr. V. C. Pennell, Pembroke College, have been re-appointed demonstrators in anatomy. The Harkness scholarship has been divided between E. R. Gee, Trinity College, and W. D. West, St. John's College. Frank Smart prizes have been awarded to T. A. Bennet-Clark, Trinity College, for botany, and to A. D. Hobson, Christ's College, and L. H. Matthews, King's College, for zoology. The Wiltshire prize has been awarded to F. C. Phillips, Corpus Christi College.

At the recent conferment of honorary degrees on the Prime Minister, Viscount Grey, Lord Plumer, Sir Aston Webb, Mr. M. C. Norman, Prof. H. A. Lorentz, Dr. W. H. Welch, and Prof. N. Bohr, the Public Orator spoke as follows in introducing the three honorary graduates in science:

"Inter speculatores omnes venatoresque Naturae quos hodie physicos proprie vocamus, constat illum eminere quem iam ad vos duco. Admodum iuvenis Physicis professor constitutus, diu in Universitate Lugduno-Batava docuit, immo vero rude donatus adhuc docet, physicorum ipse Nestor. Multa linguarum scientia, multa rerum cognitione, miro ingenii acumine, talis est studiorum hortator, ut illis qui Naturae secreta explorant etiam si non adhuc penitus inveniunt verbo exemplo benignitate praecipue subveniat. Longam iam virorum seriem recolimus qui, post reformatam Ecclesiam et Lugduni constitutam Academiam, vitae Brittanicae Batavi lucem porrexerunt. Hodie lucis ipsius investigatorem honoramus qui nobis qua ratione inter se lux et vis electrica congruant et cohaereant exposuit. Si Academiae nostrae laudes hospiti nostro narrarem nonne verba illa primum arriperem, 'Hinc lucem'? et cum hospitem Universitati vestrae praesento, quid nisi eadem mihi succurrunt, 'Hinc lucem'? Duco ad vos Henricum Antonium Lorentz.

"Revocamus illum qui, apud Vergilium, augurio spreto, neglecta cithara, fama militari recusata,

ut depositi proferret fata parentis,
scire potestates herbarum usumque medendi
maluit et mutas agitare inglorius artes.

Eandem et hodie generis humani curam, eundem medendi amorem, easdem artes agnoscimus, sed non illum inglorium vocamus, qui vitam totam medicinae consecravit, qui discipulos usum illum plurimos docuit, qui non contentus translaticiam tradere scientiam secreta Naturae voluit ipse explorare et

venienti occurrere morbo.

Virum talem vobis praesento, Yalensem, in illa republica natum quae reipublicae normam dedit ampliori, multorum in Academia Baltimorensi doctorem, diu honoratum, diu amatum, necnon et Templi illius quod Novi Eboraci posuit Hygeae Propugnatrici Rockefeller, Flaminem Rectorem Archiatrum. Duco ad vos Willelmum Henricum Welch.

"Iterum inter nos praesentem salutamus alumnum et condiscipulum qui Danus, patre natus physiologo clarissimo, in rebus physicis ipse versatus, Angliam admodum iuvenis petiit, et ad Canum et apud Mancunienses et didicit et docuit. Illud laeti revocamus, quod apud Anglos primo investigavit quomodo re vera emittatur lux, quod cum patefecisset, atomi structura quae diu latebat magis intelligebatur. Hos tantos labores praemio Nobeliano coronatos quis mirabitur? sed ex eis quae scientiae speranda sint incrementa, quis divinabit? Quippe ad patriam reverso civium voluntate—quod ceteris gentibus exemplo sit!—facultas datur ut haec studia discipulis adiuvantibus libere prosequatur. Duco ad vos Niels Bohr."

EDINBURGH.—An anonymous donor has given the University a sum of 20,000*l*. to form the nucleus of a fund to provide a new Department of Zoology. In his letter to the Principal, Sir Alfred Ewing, the donor referred to the inadequacy of the present laboratories and to the serious disadvantages under which teaching and research in zoology are being carried on in Edinburgh, and stated that he hoped other support would be forthcoming so that the new Department might be erected in the near future.

The building in which the teaching of zoology is at present carried on forms part of the Old College, and was altered in 1882, so far as structural conditions would permit, in the endeavour to meet the needs of that time. Since then there has been a great development in the subject and in the methods by which it is taught, calling especially for more laboratory accommodation and better lighting, and in both these respects the present premises are wholly inadequate to meet the needs of the students—science and medical—and of the post-graduate workers in the Department. In addition to providing instruction for science students extending over four years, and for medical students in their first year, the work of the Department includes post-graduate courses in medical entomology, protozoology, and helminthology, for the diploma in tropical medicine and in public health. The accommodation in the existing premises, barely sufficient to meet the needs of forty years ago, has been hopelessly overtaxed during the last twenty years, and no alteration of the present building can remedy the defect. Strong hopes are entertained that the recent generous gift will be supplemented, and that the University Court will be able at an early date to proceed with the erection of the laboratories urgently needed for teaching and for research.

LEEDS.—Huddersfield Town Council has decided to make a contribution of 1000*l*. a year towards the maintenance of the University.

The following appointments have been made: Mr. George R. Ross to be lecturer in bacteriology, and Mr. R. Stoneley to be assistant lecturer in applied mathematics.

Prof. Jamieson has been appointed pro-vice-chancellor for a period of two years from July 1 in succession to Prof. A. Smithells.

LONDON.—At a meeting of the senate on June 20 the following appointments were made:—

Prof. F. Wood Jones, to the University chair of anatomy tenable at St. Bartholomew's Hospital

Medical College. Prof. Jones has been demonstrator and lecturer in anatomy at the medical schools in London and Manchester, and since 1919 he has been professor of anatomy in the University of Adelaide. He is the author of "Arboreal Man," "The Principles of Anatomy as seen in the Hand," and numerous other publications.

Mr. E. C. Williams, to the Ramsay Memorial chair of chemical engineering tenable at University College. Mr. Williams was awarded the Dalton chemical scholarship for research at Manchester, and he has since been on the scientific staff of the British Dyes, Ltd., and head of the department for the manufacture of intermediate products under the British Dyestuffs Corporation. Since 1921 he has been research chemist to the joint research committee of the University of Leeds and the National Benzol Association.

Dr. R. J. S. McDowall, to the University chair of physiology tenable at King's College. Dr. McDowall was lecturer in physiology at Edinburgh, and, since 1921, lecturer in experimental physiology and experimental pharmacology at Leeds. He is the author of publications on mammalian muscle, pulmonary circulation, and numerous other physiological subjects.

Mr. G. Stead, to the University readership in physics tenable at Guy's Hospital Medical School. Mr. Stead has been, since 1910, assistant demonstrator in the Cavendish Laboratory, Cambridge, and is the author of numerous publications embodying the results of research on the passage of electricity through gases.

The following doctorates were conferred: *D.Sc.* (*Engineering*): Mr. J. V. Howard (University College), for a thesis entitled "The Tension Test in relation to the Composition of Steel"; and Mr. S. L. Smith (Imperial College—City and Guilds College), for a thesis entitled "Mechanical Hysteresis and Tensile Deformation of Steel."

MANCHESTER.—The Sir Clement Royds memorial scholarship in chemistry of the value of 300*l.* is being offered to candidates born or resident in the county of Lancaster, preference being given to the county borough of Rochdale. Further particulars are obtainable from the Internal Registrar, to whom applications must be sent by, at latest, July 14.

Dr. H. S. Raper has been appointed Brackenbury professor of physiology and director of the Physiological Laboratories. Dr. Raper, who is at present professor of physiology and biochemistry in the University of Leeds, was engaged in research work during the War on protection against poison gas, and from 1918 was head of the Anti-Gas Department. He is at present retained by the War Office in an advisory capacity on physiological questions arising in connexion with chemical warfare.

The following additional appointments have also been made: Dr. T. M. Bride to be chemical lecturer in ophthalmology; Miss Irene J. Curnow to be assistant lecturer in geography; Mr. David Stewart to be assistant lecturer in anatomy; Mr. E. V. Ashcroft and Miss Eugenia R. A. Cooper to be demonstrators in anatomy; and Mr. W. H. Wood to be tutor and secretary to the Faculty of Medicine.

THE examination for the Aitchison memorial scholarship, value 36*l.*, covering the full-time day courses in technical optics at the Northampton Polytechnic Institute, extending over two years, will be held on September 25-26 next. It is open to candidates of both sexes. Full particulars can be obtained from the Hon. Secretary and Treasurer, Mr. H. F. Purser, 35 Charles Street, Hatton Garden, E.C.1.

APPLICATIONS for grants for 1924 from the Van 't Hoff Fund, which are made to investigators in the fields of pure and applied chemistry, must be sent before November 1 by registered post to: Het Bestuur der Koninklyke Akademie van Wetenschappen; bestemd voor de Commissie van het "Van 't Hoff-fonds," Trippenhuis, Kloveniersburgwal, te Amsterdam. A detailed account of the proposed use of the grant, and of the reasons on which the candidate bases his claim, should accompany the application. The amount available for 1924 is about 1400 Dutch florins.

THE Commissioners for the Exhibition of 1851 announce that Senior Studentships for 1923 have been awarded to the following: Dr. W. Davies, demonstrator and lecturer in chemistry at the University of Oxford; Dr. L. C. Jackson, science research scholar in physics of the Royal Commission of 1851, at the University of Leyden; Mr. J. H. Quastel, research student in bio-chemistry at the University of Cambridge; Mr. D. Stockdale, research student in metallurgy in the Goldsmiths' laboratory at the University of Cambridge, and demonstrator in the University Chemical Laboratory; and Mr. H. Williams, research student in geology at the University of Liverpool.

ON June 22, the Universities of Oxford and Cambridge Bill was before the House of Commons, and the second reading was agreed to without a division. It will be remembered that the Bill is a result of the report of the Royal Commission appointed in November 1919 to investigate financial and other conditions at Oxford and Cambridge. Under its provisions, two bodies of commissioners will be appointed, of which Lord Chelmsford and Lord Ullswater are to be the respective chairmen, to direct affairs in the Universities for five years. There is also provision for financial aid for each University; the Royal Commission suggested an annual grant of at least 70,000*l.* in addition to the 30,000*l.* already received annually by Oxford and Cambridge.

THE excessive prolongation of merely preparatory general education is trenchantly criticised in the annual report for 1922 of the Carnegie Foundation for the Advancement of Teaching. It is pointed out that the "High School" was intended originally to form for the common people of the country a college in which their sons and daughters might be prepared for various practical callings just as the college proper prepared its students for the learned professions. The high school and college offered in fact *parallel* modes of education. The high school gradually came under the complete domination of the academic colleges and universities until the former became, what it is in large measure to-day, a vestibule to the college, even though but a small number of its students proceed to college. There has resulted an "Educational pyramid" comprising 8 years in the elementary school (from age 6 to age 14), 4 years in the high school, and 4 years in college—in all 16 years of preparatory training in schools the primary purpose of which is assumed to be cultural. "The like of this is not to be seen in any other part of the world. . . . Without question 4 years can be dropped out of the programme with advantage to the cause of education and to the interest of the people and of their children. But this change also is clearly related to that conception of education which assumes that the beginning of education lies in the sincere learning of a few things rather than in the superficial acquaintance with many."

Societies and Academies.

LONDON.

Royal Microscopical Society (Industrial Applications Section), May 30.—Dr. A. Hutchinson in the chair.—H. B. **Milner**: The microscopical investigation of sands for various industrial purposes. The application of the petrological microscope to the discrimination of sands and allied rocks suited to various industrial requirements, such as glass manufacture, abrasives, ferrous and non-ferrous foundry work, silica-brick production, cement, mortar, concrete, brick and tile manufacture, and as a source of economically valuable minerals such as monazite and thorianite for incandescent gas mantles, etc., was discussed. The distinctive properties of sands for their proper utilisation in the arts can be determined by the microscope. The employment of the microscope should not be interpreted as a certain cure for all technical difficulties, but the full possibilities of the instrument are still unappreciated by the majority of manufacturers who employed refractory materials. Lines of microscopical research on refractory sands, particularly in connexion with silica-bricks, were suggested.

Aristotelian Society, June 4.—Prof. A. N. Whitehead, president, in the chair.—Sir Leslie **Mackenzie**: What does Dr. Whitehead mean by "event"? The word has a peculiar importance in his theory. It is intended to cover the fact that, on whatever theory we finally decide as to the nature of the physical world, that world cannot now be described or even discussed except abstractly if we confine ourselves to terms of space alone; for space and time have a common root, and, if we speak in terms of space alone, we can properly do so only in one of two ways: either we must use space as meaning space-time or simply as a second grade of abstraction. In either case it omits the essential point that the physical world is to be taken in terms of space and time in unity. At first sight, the word "event" seems to overstress the time element. The fact of a happening is thought of first in terms of time and not in terms of space. But it is something perceptible that happens, and if it took no time to happen, it would not be perceptible; for it would be nothing at all. Time, therefore, is of the essence of every happening. But equally there is no doubt that what happens physically happens in a space, it happens somewhere, and every physical happening must be thought of as also in space. Whether explicitly so understood or not, every event in the physical world is, therefore, a thing to be thought of as involving both time and space.

Geological Society, June 6.—Prof. W. W. Watts, vice-president, in the chair.—H. **Bolton**: On a new blattoid wing from the Harrow Hill mine, Drybrook (Forest of Dean). The wing is a right fore-wing of a new genus of blattoid, and of unusual size. The surface is densely chitinous, and crossed by a series of powerful well-branched veins, the cubitus being especially well developed, and much unlike any other known among the Coal-Measure blattoids. The insect probably occupied an intermediate position between the families Archimylacridæ and Hemimylacridæ. — C. E. **Tilley**: Contact-metamorphism in the Comrie area of the Perthshire Highlands. The thermal aureole of the Cairn Chois diorite-complex is divisible into (*a*) zone of biotite and (*b*) zone of cordierite, which rapidly passes into a zone of true hornfelses. In the Aberfoyle-Slate band, an additional outer zone (zone of spotted slates) is found; but no chemical reconstruction is apparent. The progression of metamorphism as here observed is that distinctive of kaolin-free slates subject to thermal alteration. The rocks of the hornfels zone—with a minimum width of 150 yards—show a wide range of composition. A classification of the silica-poor hornfelses is suggested, starting from a simplified system of four components. The mineralogical assemblages thus ideally determined can be alternatively developed from a consideration of the chemical changes incident on metamorphism of sericite-chlorite-quartz assemblages of the original rocks. Certain abnormal assemblages are considered as unstable. These, while not invalidating the hornfels classification adopted, serve to indicate that equilibrium in the inner contact-zone is closely approached rather than completely attained.

Linnean Society, June 7.—Dr. A. B. Rendle, president, in the chair.—H. **Sandon**: Some Protozoa from the soils and mosses of Spitsbergen obtained by the Oxford University Expedition.—J. D. F. **Gilchrist**: A form of dimorphism and asexual reproduction in *Ptychodera capensis*. C. E. **Moss**: The species and forms of Salicornia in South Africa.—J. **Burtt-Davy**: Geographical distribution of some Transvaal Leguminosæ. The Leguminosæ form the largest family of Transvaal Spermatophyta, as regards numbers of species, having about 100 species more than the Compositæ, and comprising nearly 10 per cent. of the recorded species of the flora. A large number of the genera have very few species. The greatest number of endemics generally occur in genera with the greatest number of species; and the species show great variation in range. Even in the same genus some range almost the length of the Continent. Classified according to their geographical range of distribution, the Papilionaceæ fall into five very distinct groups: (1) the South-western Cape Province element, (2) the Kalahari element, (3) the Rain-forest element of the eastern high mountains, (4) the Tropical African element, and (5) the Warm Temperate Plateau element. (4) and (5) account for 94 per cent. (306 species) of the total Papilionaceous flora and 123 are endemic to the Transvaal. Adding to these species those which range into the states bordering on the Transvaal but not beyond them, the number of endemics forms 78 per cent. of the population. Fifteen species (less than 5 per cent.) are common to the Transvaal and India, and five species are found in Madagascar. In connexion with the view that arborescent forms are the older types, it is noteworthy that, with one exception, possibly introduced, the arborescent and shrubby species of Papilionaceæ (only about twenty in all) belong to the Tropical African element, and about half of them belong to genera with few species. —C. E. **Moss**: Velaminous roots in terrestrial orchids. They are especially noticeable in the orchid genus Eulophia, abundant at the Cape (S.A.).

Physical Society, June 8.—Dr. Alexander Russell in the chair.—J. G. **Gray**: A general solution of the problem of finding the true vertical for all types of marine and aerial craft. The difficulties presented by this problem arise from the horizontal accelerations which result from the turning of vehicles. A gyroscopic pendulum to succeed must possess a real precessional period, or a virtual precessional period during turning motion of the vehicle on which it is mounted, which is measured in hours. Pioneer forms of Gray stabiliser comprise a single gyroscope, mounted with its axis normally vertical, and an erector connected rigidly to it; the whole is pivoted to a gimbal frame by means of two cross pivots. One form of erector consists of a circular track carried by the pivoted system, and so arranged that when the pivoted system is upright the track is horizontal. One, two, or more balls rotate on the track, each controlled by a pusher and a check carried by a member which rotates slowly (about 12 revolutions per minute) in the direction of spin of the gyroscope. When the system is upright the balls move round the track in contact with their pushers, and form a balanced system. When the system is inclined to the vertical the track is inclined to the horizontal, and each ball when ascending the slope of the track rests against its pusher, but after crossing the crest of the slope it is accelerated down the track and rests against its check. The motion of the balls relative to the pushers and checks results in the application to the pivoted system of an integral erecting couple. Such instruments possess an accuracy, for bombing purposes, amounting to one-eighth or one-tenth of a degree, or about 20 feet on the ground from a height of 12,000 feet. Later forms of Gray stabiliser set themselves into the true vertical even when the vehicles on which they are mounted are turning, and this holds for all speeds of turning. This result is obtained by constructing the apparatus so that a horizontal component of spin lies across the pivoted system, which is mounted so as to be pendulous with respect to the pivots. The direction of the horizontal spin, and its amount, are arranged so that when the vehicle turns there comes into existence a gyroscopic couple, applied about the fore and aft pivots, which is exactly equal and opposite to the so-called centrifugal couple applied to the pivoted system. Both couples are proportional to the angular speed at which the vehicle turns, and both change sign with that of the turning motion.

Zoological Society, June 12.—Sir S. F. Harmer, vice-president, in the chair.—N. A. **Mackintosh**: The chondrocranium of the teleostean fish *Sebastes marinus*.—R. I. **Pocock**: The external characters of the pigmy hippopotamus (*Chæropsis liberiensis*) and of the Suidæ and Camelidæ.—E. E. **Austen**: A revision of the family Pantophthalmidæ (Diptera), with descriptions of new species and a new genus. —Raymond **Dart** and C. W. **Andrews**: The brain of the Zeuglodontidæ (Cetacea), with a note on the skulls from which the endocranial casts were taken. —R. **Broom**: On the structure of the skull in the carnivorous dinocephalian reptiles.—Oldfield **Thomas** and M. A. C. **Hinton**: On mammals collected by Capt. Shortridge during the Percy Sladen and Kaffrarian Expedition to Orange River.

PARIS.

Academy of Sciences, June 4.—M. Albin Haller in the chair.—Charles **Richet**: The function of the spleen in nutrition. An account of some feeding experiments on dogs after removal of the spleen.—Gabriel **Bertrand** and Mlle. S. **Benoist**: A new sugar, procellose. Filter paper is converted into cellulose octacetate by the method of Maquenne and Goodwin, and the mother liquors from the crystallisation of this acetate worked up for the isolation of the new sugar, to which the name procellose is given. Its composition is $C_{18}H_{32}O_{16}$ and rotation $[\alpha]_D = +22°·8$ at 21° C.; its reducing power is half that of glucose. Its probable formula is given.—C. **Guichard**: Two triple orthogonal systems which correspond in such a manner that the first tangents to the two systems are reciprocal polars with respect to a linear complex. —Sir Richard Hadfield was elected corresponding member for the section of chemistry in succession to M. Paterno, elected foreign associate.—René Maire was elected corresponding member for the section of botany in succession to the late M. Battandier.—Jules **Drach**: Remarkable classes of W congruences.—Bertrand **Gambier**: The curves of Bertrand, and in particular, those which are algebraical.—MM. **Schouten** and **Struik**: A theorem of conformal transformation in differential geometry of n dimensions.—M. **Lainé**: The integration of differential equations.—Serge **Bernstein**: A property of integral functions.—Henri **Eyraud**: Multiple spaces and tensors.—M. **Chatillon**: The paramagnetism of cobalt sulphate in aqueous solution. An explanation of the divergent results of Cabrera and Trümpler on the coefficient of magnetisation of cobalt salts. With solutions prepared at ordinary temperatures, the results are independent of the concentration, but if the solutions are prepared hot and allowed to cool to the ordinary temperature, the atomic moment is a function of the concentration. —M. **de Broglie** and A. **Lepape**: The K absorption discontinuity of krypton and xenon. Krypton gave N = 36 (λ = 0·8648Å) and xenon N = 54 (λ = 0·3588Å). The last figure is approximate only.—L. **Bull**: A photographic technique for detecting minute deformations in rectilinear objects.—Adolphe **Lepape**: The quantitative measurement of radium emanation by the α-radiation. Corrections due to pressure and to the nature of the gaseous mixture. Corrections, generally neglected, should be applied to measurements of radium emanation: their importance depends not only on the variations of density and composition of the gas present in the condenser, but also on the dimensions of the latter.—Jean **Barbaudy**: The removal of toluene by steam.—A. **Boutaric** and Mlle. Y. **Nabot**: The influence of a third substance on the miscibility of phenol and water.—Marcus **Brutzkuo**: A contribution to the theory of internal combustion motors. Some theoretical considerations of the combustion of gases and liquids in engine cylinders derived from the application of the law of mass action.—Henri **Guinot**: A continuous method of dehydrating alcohol and certain organic liquids. A modification of the Young method for dehydrating alcohol, in which the benzene proposed by Young is replaced by trichlorethylene. The distillate separates into two layers, the lower layer containing only 2 per cent. of water and practically the whole (99 per cent.) of the trichlorethylene. This is returned to the still. —P. **Brenans** and C. **Prost**: The iodosalicylic acids. The 1.2.3 and 1.2.5 mono-iodide acids have been prepared, starting with aminosalicylic acids of known constitution: each of these has been transformed into the same 1.2.3.5 di-iodosalicylic acid.—A. **Blanchetière**: The action of dry heat on the alkaline earth salts of the carbamine acids.—L. **Cayeux**: The rôle of the crinoids in the history of the secondary oolitic iron minerals. The contribution of the remains of crinoids to the constitution of the oolitic iron minerals of the secondary epoch is of great importance.—Pierre **Bonnet**: The Neocretacian of Daralagœz (southern Transcaucasia).—P. H. **Fritel**: Two species of ferns new to the fossil flora of the millstone grit of Beauce (Aquitanian).—M. **Gruvel**: Some coral deposits on the western coast of Morocco. —L. **Éblé**: Magnetic measurements in the Paris basin. The values of the magnetic elements calculated to January 1, 1922, are given for 40 stations, ten of which are new.—R. de Montessus **de Ballore**: The methodical prediction of the weather. The results of a study of statistics given by Louis Besson in 1905.—J. **Rivière**: The variation of nocturnal temperature with a clear sky.—G. **Reboul**: The acoustic opacity of banks of clouds: application to the rapid determination of the thickness of a cloud layer.—Maurice **Lenoir**: The nucleolar material during the telophase of somatic kinesis in the nucleus in *Fritillaria imperialis*.—J. **Athanasiu**: Motor nerve vibrations in the animal series.—E. **Wollman** and M. **Vagliano**: The action of light on growth. A description of three sets of experiments on rats: the diet of the first set contained 5 per cent. of butter, and of the second and third sets 1 per cent. of butter. The rats were kept in the dark, but the third set were exposed to ultra-violet light from a mercury vapour lamp for 3 to 5 minutes each day. Other experiments were carried out in which the rats received only 1 per cent. of butter but were exposed to light. The growth of rats receiving only 1 per cent. of butter and exposed to daylight or to ultra-violet light was as rapid as those receiving the larger amount of butter and kept in the dark. If the food contained no butter, irradiation by the mercury lamp had no effect. Light alone cannot compensate for the absence of the fat soluble factor of growth.—Georges **Mouriquand** and Paul **Michel**: Some osteodystrophic factors and their action according to the species of animal. Dietic experiments, with deficiency of the C-vitamin, on rats and guinea-pigs show that these animals present marked differences in bone nutrition under the same conditions of food. The experiments will be extended to other species of animals, and it is pointed out that it is necessary to apply the results of feeding experiments with animals with much care, especially as regards man.—P. **Gillot**: The variations of some carbohydrate reserves in *Mercurialis perennis*. Maltose, which is always present in the reserve organs of this plant, undergoes variations comparable with those of the starch and saccharose: hence this sugar may be looked upon as a reserve substance of the same order as the other polysaccharides.—Georges **Tanret**: Some bases, of the type of tropacocaine, derived from pseudopelletierine.—E. **Kayser**: —The action of yeast on calcium lactate: the production of ethyl alcohol.—Alphonse **Labbé**: The critical zones of adaptation to the medium.—L. **Berland**: The origin of the spiders of New Caledonia. Of 150 species of spiders found, 93 species are confined to that island. The species are most probably of Malay origin in the Oligocene period.—René **Jeannel**: The evolution of the blind Coleoptera and the stocking of the caves in the mountains of Bihor in Transylvania.—Eugène **Lacroix**: The fundamental chitinous texture of the shell of certain Foraminifera. —Armand **Dehorne**: The interstitial cells in the testicle of annelids, Stylaria, and Lumbricus.—Maxime **Ménard** and **Saidman**: The action of the ultra-violet rays on superficial wounds. Details of 17 cases submitted to this treatment, of which 12 were cured and 3 improved.

SYDNEY.

Royal Society of New South Wales, May 2.—Mr. C. A. Sussmilch, president, in the chair.—C. A. **Sussmilch**: Presidential address. No volcanoes either active or dormant occur now in New South Wales, but there is abundant geological evidence to show that at many stages in its past history numerous large active volcanoes existed. Each subdivision of the Palæozoic era had its active volcanoes; during the Ordovician period submarine eruptions took place in the central part of the State. Later, volcanic activity appears to have been confined to the New England area, but here it occurred on a grand scale. A chain of active volcanoes extended from Port Stephens past Maitland, Musclebrook, and Scone, and from thence northwards to Currabubula, and active volcanoes occurred at Gloucester and on the Drake Goldfield. The lavas and tuffs poured out from these volcanoes aggregated many thousands of feet in thickness. In the succeeding Permo-Carboniferous period, when the great coalfields were being laid down, volcanic activity, while less intensive, was still present. In the Mesozoic era, the volcanic forces appear to have died out, and for several millions of years volcanic activity was unknown. In the succeeding Cainozoic era volcanic activity again asserted itself, and twice at least floods of basaltic lavas were poured out, submerging vast tracts of land, and completely covering up some of the then river valleys, thus preserving some of the deep leads afterwards worked for gold, tin, and gemstones. Towards the end of this era, a number of isolated groups of volcanic cones developed; these were the last eruptions to occur in New South Wales, and for the past million or so years volcanic activity has been entirely absent.

Official Publications Received.

Department of Commerce: Scientific Papers of the Bureau of Standards. No. 469: Directive Radio Transmission on a Wave Length of Ten Metres. By Francis W. Dunmore and Francis H. Engel. Pp. 16. 10 cents. No. 473: A Method for the Measurement of Sound Intensity. By J. C. Karcher. Pp. 105-111. 5 cents. (Washington: Government Printing Office.)

The Botanical Society and Exchange Club of the British Isles. Vol. 6, Part 5: Report for 1922. By the Secretary, G. Claridge Druce. Pp. 589-821. (Arbroath: T. Buncle and Co.) 10s.

Rhodesia Museum, Bulawayo. Twenty-first Annual Report, 1922. Pp. 18. (Bulawayo.)

The Royal Society for the Protection of Birds. Thirty-second Annual Report, January 1 to December 31, 1922; with Proceedings of Annual Meeting, 1923. Pp. 80. (London: 82 Victoria Street.)

Bergens Museum. Aarsberetning, 1921-1922. Pp. 103. (Bergen.)

Bergens Museum Aarbok, 1920-1921. 2 Hefte. Naturvidenskabelig Række. Pp. 96+71. (Bergen.)

Department of the Interior: Bureau of Education. Bulletin, 1922, No. 45: Status of Certain Social Studies in High Schools. By Harry H. Moore. Pp. 21. 5 cents. Bulletin, 1923, No. 12: Secondary Education in 1921 and 1922. By W. S. Deffenbaugh. Pp. 30. 5 cents. (Washington: Government Printing Office.)

State of Illinois Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 14, Art. 3: A Study of the Malarial Mosquitoes of Southern Illinois. By Stewart W. Chandler. 2: Operations of 1920. Pp. 23-32. Vol. 14, Art. 4: Changes in the Bottom and Shore Fauna of the Middle Illinois River and its Connecting Lakes since 1913-1915 as a Result of the Increase, Southward, of Sewage Pollution. By Robert E. Richardson. Pp. 33-75. Vol. 14. Art. 5: The Helminthosporium Foot-rot of Wheat, with Observations on the Morphology of Helminthosporium and on the Occurrence of Saltation in the Genus. By F. L. Stevens. Pp. iv+77-186+25 graphs+plates 7-34. Vol. 14, Art. 6: The Numbers and Local Distribution in Summer of Illinois Land Birds of the Open Country. By Stephen A. Forbes and Alfred O. Gross. Pp. 187-218+plates 35-68. Vol. 14, Art. 7: Coddling-Moth Investigations of the State Entomologist's Office, 1915, 1916, 1917. By Pressley A. Glenn. Pp. iv+219-289. (Urbana: Department of Registration and Education.)

Department of the Interior: United States Geological Survey. Bulletin 729: Oil Shale of the Rocky Mountain Region. By Dean E. Winchester. Pp. 204+18 plates. Bulletin 734: Deposits of Manganese Ore in the Batesville District, Arkansas, by Hugh D. Miser; with a Chapter on the Mining and Preparation of the Ores, by W. R. Crane. Pp. xi+273+17 plates. 45 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 504: Surface Water Supply of the United States, 1919-1920. Part 4: St. Lawrence River Basin. Pp. iv+188. (Washington: Government Printing Office.) 20 cents.

Department of the Interior: United States Geological Survey. Professional Paper 131-F: Revision of the Flora of the Green River Formation, with Descriptions of New Species. By F. H. Knowlton. Pp. 133-182 +plates 36-40. Professional Paper 131-G: Fossil Plants from the Tertiary Lake Beds of South-Central Colorado. By F. H. Knowlton. Pp. 183-197 +plates 41-44. Professional Paper 131-H: The Fauna of the So-called Dakota Formation of Northern Central Colorado and its Equivalent in South-Eastern Wyoming. By John B. Reeside, Jr. Pp. 199-212+plates 45-50. (Washington: Government Printing Office.)

Queensland Geographical Journal (New Series). Vols. 36-37. Including the Proceedings of the Royal Geographical Society of Australasia, Queensland. 36th-37th Sessions, 1920-1922. Pp. iv+128. (Brisbane: Royal Geographical Society.)

Diary of Societies.

MONDAY, JULY 2.

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

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—M. Ginsberg: The Category of Purpose in Social Science.

FARADAY SOCIETY (at Chemical Society), at 8.—A. Ferguson: A Relation between Surface Tension and Density.—J. Grant and Prof. J. R. Partington: Concentration Cells in Methyl Alcohol.—U. R. Evans: The Law of Definite Proportions in the Light of Modern Research.—J. B. Firth: Determination of the Density of Charcoal by Displacement of Liquids.—F. G. Tryhorn and S. C. Blacktin: The Formation of Anomalous Liesegang Bands.

Recent Scientific and Technical Books

Volumes marked with an asterisk have been received at "NATURE" *Office.*

Mathematics

Baker, H. F. Principles of Geometry. Vol. 2: Plane Geometry, Conics, Circles, Non-Euclidean Geometry. Demy 8vo. Pp. xv+243. (Cambridge: At the University Press, 1922.) 15*s.* net.*

Bruhns, Dr., Edited by. A New Manual of Logarithms to Seven Places of Decimals. Thirteenth stereotype edition. Sup. Roy. 8vo. Pp. xxiv+610. (London: Chapman and Hall, Ltd., 1922.) 12*s.* 6*d.* net.*

Coventry, W. B. The Racing Eight: Notes on its Design and Propulsion. Cr. 8vo. Pp. iv+39. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1922.) 3*s.* 6*d.* net.*

Goursat, E. Leçons sur le problème de Pfaff. 8vo. Pp. viii+386. (Paris: J. Hermann, 1922.) 30 francs.

Macgregor, D. C. Mathematics and Physical Science in Classical Antiquity. Translated from the German of J. L. Heiberg. (Chapters in the History of Science, II.) Cr. 8vo. Pp. 110. (London: Oxford University Press, 1922.) 2*s.* 6*d.* net.*

Moch, G. Initiation aux théories d'Einstein. (Bibliothèque Larousse.) 8vo. Pp. 160. (Paris: Libr. Larousse, 1922.) 4 francs.

Moreux, L'Abbé Th. Pour comprendre la géométrie plane. Fcap. 8vo. Pp. 252. (Paris: G. Doin, 1922.) 8 francs.

Neville, E. H. Prolegomena to Analytical Geometry in Anisotropic Euclidean Space of Three Dimensions. Imp. 8vo. Pp. xxii+368. (Cambridge: At the University Press, 1922.) 30*s.* net.*

Otzen, R., Herausgegeben von. Handbibliothek für Bauingenieure: Ein Hand- und Nachschlagebuch für Studium und Praxis. Teil I: Hilfswissenschaften. Erster Band: Mathematik. Von H. E. Timerding. 8vo. Pp. viii+242. (Berlin: J. Springer, 1923.)

Shaw, J. B. Vector Analysis: with Applications to Physics. Ex. Cr. 8vo. Pp. v+314. (London, Bombay and Sydney: Constable and Co., Ltd., 1922.) 14*s.* net.*

Wulf, Le P. Th. La Théorie de la relativité d'Einstein. Traduit par le P. H. Dopp. 8vo. Pp. 96. (Bruxelles: A. Dewett, 1922.) 2 francs.

Mechanics: Mechanical Engineering

Aeronautical Research Committee. Reports and Memoranda. No. 541: Stability and Resistance Experiments on a Model of Vickers' Rigid Airship R.80. 6*d.* net. No. 769: The Calculation of Stresses in a Redundant Structure by the Method of Comparison of Deflections, with Examples of its Application to Aeroplane Design. 1*s.* 6*d.* net. No. 773: Lateral Control at large Angles of Incidence: Yawing and Rolling Moments due to Aileron Movement on a complete Model of S.E. 5a. 9*d.* net. No. 779: Experiments on a Model of Rigid Airship R.32, together with a Comparison with the Results of Full-Scale Turning Trials and a Consideration of the Stability of the Ship. 9*d.* net. No. 780: Aerodynamic Pressure on an Airship Hull in Curvilinear Flight. 6*d.* net. No. 781: The Motion of Airships under certain imposed Movements of the Rudders. 1*s.* 3*d.* net. No. 782: Equilibrium of R.38 in Circling Flight. 3*d.* net. No. 784: Seaplane: Taking Off and Alighting. 3*d.* net. No. 785: Experiments with Model Flying Boat Hulls and Seaplane Floats. 1*s.* net. No. 786: An Aerodynamic Theory of the Airscrew. 9*d.* net. No. 787: Lateral Control of Bristol Fighter at Low Speeds: Measurement of Rolling and Yawing Moments of Model Wings due to Rolling. 1*s.* 6*d.* net. No. 788: Theoretical Streamlines round a Joukowsky Aerofoil. 3*d.* net. No. 789: Preliminary Report on the Properties of commercially Pure Nickel as a Standard Material for Fatigue Investigations. 9*d.* net. No. 790: On the Determination of the Stresses in Braced Frameworks: Part 1, The Effect of Shear upon a Framework of Uniform Rectangular Cross-section. 6*d.* net. No. 791: On the Determination of the Stresses in Braced Frameworks: Part 2, The Effect of Axial Loading, Torsion, Flexure, and Shear upon a Braced Tube of any Uniform Cross-section. 6*d.* net. (London: H.M. Stationery Office, 1922.)

Batson, R. G., and Hyde, J. H. Mechanical Testing: a Treatise in Two Volumes. Vol. 2: Testing of Prime Movers, Machines, Structures and Engineering Apparatus. (Directly-Useful Technical Series.) Demy 8vo. Pp. xi+446. (London: Chapman and Hall, Ltd., 1922.) 25*s.* net.*

Bouasse, H. Hydrostatique: Manomètres, baromètres, pompes: Équilibre des corps flottants. (Bibliothèque scientifique de l'Ingénieur et du Physicien.) 8vo. Pp. xxiv+480. (Paris: Libr. Delagrave, 1923.) 30 francs.

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The Water in the Atmosphere.[1]

By Dr. G. C. Simpson, F.R.S., Director of the Meteorological Office.

THE dictionary definition of "saturation" is "the state of a body when quite filled with another," and it is usual to think of saturated air as air which is full of water vapour to such an extent that further water cannot be added without condensation taking place. This, however, is a wrong conception, for there is no limit to the amount of water vapour which air can contain at any temperature, provided that it is perfectly pure, except that ultimately the molecules of vapour will be so near together that there will be no distinction between vapour and liquid.

Air at 30° C. is said to be saturated when its vapour pressure is 31·51 mm. of mercury, but if to such saturated air we add water in sufficiently small drops it will be evaporated immediately and the liquid drops transformed into invisible vapour. If we could add drops with so small a diameter as $1{\cdot}6 \times 10^{-7}$ cm. the air would devour them with avidity until its vapour pressure was more than 126 mm., and then would be ready for more if smaller drops could be supplied.

The question of whether air can hold more vapour or not depends entirely on how the water is presented to it. If the water is presented with a flat surface, evaporation will take place until there is so much water vapour present in the air that as many water molecules return to the surface as leave it; the air is then saturated with reference to a flat surface of pure water. If the surface is curved—convex towards the air—more water molecules will leave each square centimetre of the surface than in the case of a flat surface; hence there must be more vapour molecules in the air before equilibrium is attained. Thus the saturation vapour pressure over a curved surface is higher than over a flat surface at the same temperature. On the other hand, if the water contains certain impurities—*e.g.* sulphuric acid, calcium chloride, and salts in general—less molecules leave the surface than in the case of pure water; hence a smaller number of molecules in the air will be sufficient to produce equilibrium over a solution.

In accordance with the usual practice we will describe air as saturated when the water vapour it contains is in equilibrium with a flat surface of pure water at the same temperature. This will define the saturation pressure at each temperature, and relative humidities will be given in terms of this saturation pressure.

It is well known that water can exist in the liquid state at temperatures far below the freezing point, and therefore water and ice may exist side by side over a large range of temperature. But the vapour pressure which is in equilibrium with ice at a given temperature is lower than that which is in equilibrium with supercooled water at the same temperature; that is, air is in equilibrium with ice at a relative humidity below 100 per cent.

Thus, according to our definition of relative humidity, the water vapour in air may be in equilibrium with water over a large range of relative humidities according to the physical state of the water present. The following tables give the relative humidity of air in equilibrium with pure water in the liquid and solid state.

Table I.

Relative humidity of air in equilibrium with water surfaces of various radii at 0° C.

Radius, cm.	Flat.	$1{\cdot}0 \times 10^{-3}$.	$1{\cdot}1 \times 10^{-5}$.	$2{\cdot}5 \times 10^{-6}$.	$7{\cdot}2 \times 10^{-7}$.	$1{\cdot}6 \times 10^{-7}$.
Relative humidity	100	100·00012	101	105	120	400

Table II.

Relative humidity of air in equilibrium with a flat surface of ice at various temperatures.

Temperature	0° C.	−10° C.	−20° C.	−30° C.	−40° C.	−50° C.	−60° C.
Relative humidity	100	91	82	74	67	61	55

Condensation at Temperatures above the Freezing Point.

It was in 1880 that Aitken first showed that condensation does not necessarily take place in air when its temperature is lowered below the dew point. He expanded carefully filtered air and found that no fog formed even when there was considerable supersaturation. Aitken was led to the conclusion "that vapour molecules in the atmosphere do not combine with each other, that before condensation can take place there must be some solid or liquid nucleus on which the vapour molecules can combine, and that the dust in the atmosphere forms the nuclei on which the water-vapour molecules condense."

Aitken invented a most ingenious instrument, easy to work and very transportable, by means of which it is possible to count the number of nuclei present in the air. Thousands of tests of the atmospheric nuclei have been made with this instrument at many places over the world, and nowhere has air free from nuclei been found. The number of nuclei is seldom less than 100 per c.c., while in most country places the nuclei rise to thousands, and in cities such as London and Paris the number may be so great as 100,000 to 150,000 per c.c.

The general explanation of these observations is as

[1] Discourse delivered at the Royal Institution on Friday, March 2, 1923.

follows. If there were no dust particles present the drops of water would have to be built up from aggregates of water molecules. Now the radius of a water molecule is 2×10^{-8} cm., therefore if a few molecules met together by chance they would only form a very small drop, which would be so small that it could not exist unless there was large supersaturation. For example, according to Table II. a drop having a radius of $7\cdot2\times10^{-7}$ cm. would require a supersaturation of 20 per cent., yet nearly 20,000 water molecules would be required to form such a drop. If, however, there were dust particles present the molecules of water would be deposited on them, and the radii of the initial drops would be so large that little supersaturation would be required to maintain them.

This explanation appeared to satisfy every one for a long time, but in recent years considerable doubt has begun to be expressed. Already, in 1885, Assmann had searched for the dust nuclei when cloud particles evaporated under the microscope, and had come to the conclusion that if any were present they must have a smaller radius than $2\cdot5\times10^{-5}$ cm.

In 1912, Wigand made the reverse experiment. He first took careful counts of the number of nuclei in the air, then he created large quantities of dust by beating carpets, blowing up large clouds of coal, coke, and ordinary dust by means of bellows. Although he made such large clouds of dust that it was extremely unpleasant to work in them, he could not find any increase in the number of nuclei in his condensation apparatus.

In 1910, A. Wegener directed attention to another difficulty. The distance one can see through the atmosphere depends on the number of dust particles present and their size. From measurements made at Ben Nevis it had been found, from a comparison between the transparency of the atmosphere and the number of nuclei measured in Aitken's instrument, that the damper the air the less the number of nuclei necessary in order to see the same distance. The observations gave the following result:

TABLE III.

Depression of the Wet Bulb.	Number of Nuclei present in 1 c.c. with a Constant Distance of Vision.
1·1-2·2° C.	$1\cdot25\times10^4$
2·2-3·9	1·71
3·9-5·5	2·26

This can only be explained if the size of the dust particles increases as the humidity increases, even when the humidity is still far below its saturation value. But this is not an effect which one would expect if the only function of the dust particles is to act as nuclei, for there would be no condensation on them until the air has reached its saturation point. At all humidities less than 100 per cent. the dust particles would remain dry and therefore of constant size.

From these and other observations meteorologists have been led to the opinion that condensation does not commence on dust particles, if dust is to be understood in the ordinary way, but on hygroscopic substances, and that Aitken's instrument does not measure the number of dust particles present but the number of hygroscopic particles.

A great deal of work has recently been done on this question, especially by Köhler in Norway. Working on a mountain in the extreme north of Norway, Köhler analysed the water obtained from the large deposits of rime which formed on the surroundings of his observatory. Rime is frozen cloud particles, and in this way he was able to determine the chemical contents of the actual cloud particles before they had had time to become contaminated. He found that calcium chloride was always present, and concluded that sea-salt obtained from the spray of the sea forms the true nuclei of cloud condensation. His results indicate that when the drops are extremely small there is sufficient salt present to reduce the vapour pressure to the same extent as the small radius of the drop increases it, thus allowing condensation to take place. Köhler is tempted to generalise his results and to contend that sea-salt is the main foreign substance on which condensation takes place. It is, however, not necessary to go so far as this, for there are many other sources of hygroscopic substances. Lenard and Ramsaner have shown that sunlight—probably only the ultra-violet part—acts on the oxygen, nitrogen, and water vapour of the atmosphere, producing very hygroscopic substances.

Large quantities of material capable of becoming condensation nuclei are produced by all processes of combustion. Thus the household fires and factory chimneys of centres of industry produce vast quantities of nucleus-forming material, chief of which is sulphurous oxide, SO_2. This, when illuminated by sunlight in the atmosphere, is a very hygroscopic substance capable of causing condensation in unsaturated air. It is estimated that in England something like 5000 tons of sulphur are burnt each day in coal fires, giving enough sulphur products to pollute the atmosphere from Land's End to John o' Groat's. Other products of combustion are also hygroscopic; thus it is not surprising that air from large industrial centres contains enormous quantities of nuclei.

It is not necessary for hygroscopic particles to be large in order for water to be deposited upon them. Their chemical affinity for water is sufficiently large to counterbalance the surface tension forces which cause small pure-water particles to evaporate unless there is supersaturation. A single molecule of a hygroscopic substance would probably be able to gather around itself sufficient water to make a drop large enough to grow by ordinary condensation. Thus, whereas the hygroscopic properties are important to build up a drop to a certain size, after that size has once been reached the hygroscopic attraction may cease through excessive dilution, but condensation will continue until the drop is in equilibrium with the surrounding vapour.

The ordinary small ion, in my opinion, takes no part whatever in meteorological processes. Before any deposition of water can take place on small ions, four-fold supersaturation is necessary in the case of negative ions and six-fold in the case of positive ions. We have absolutely no evidence of anything like these supersaturations in the atmosphere, and I have shown at some length, in a paper published in the *Philosophical Magazine*, that even in the case of thunder-storms, in which the conditions are by far the most favourable for the formation of supersaturated air, small ions take no part in the condensation. Further, we have no evidence that small ions act like hygroscopic substances; they do not appear to grow appreciably in size in saturated air, in fact they act like any other air molecule until four-fold or six-fold supersaturation is actually reached.

With regard to large ions (Langevin ions), these do appear from Pollock's work to grow with increase of humidity; but, as Pollock found that they do not form in pure air, these ions are probably nothing more than ordinary hygroscopic nuclei, with a small ion attached.

Without detracting in any way from the value of Aitken's work, we see that it is necessary to revise his conclusions, and to say that hygroscopic substances and not dust form the nuclei of condensation. I do not think that Aitken would have been surprised at this development of his work, for he clearly recognised the importance of salt particles as efficient nuclei.

Condensation at Temperatures below the Freezing Point.

When the temperature of the air is below the freezing point, condensation of the contained water vapour is a still more difficult problem, for there is very little experimental evidence to go upon. One thing is certain: owing to the small amount of vapour present, it is inconceivable that condensation will take place by the fortuitous meeting of molecules; some kind of nuclei therefore will be necessary.

According to experiments made on crystallisation from supersaturated solutions, we may conclude that crystallisation does not start readily on a perfectly spherical surface. An angular nucleus is necessary, and the nearer the angles are to those of the natural angles of the crystal the more readily will condensation take place. When sledging in the Antarctic with Captain Scott in 1911 we became enveloped in a fog during sunshine. On the fog opposite the sun we saw a white bow in the position usually occupied by a rainbow. This phenomenon can only be explained on the assumption that the fog was composed of small spheres; but the temperature was $-29°$ C. ($-21°$ F.). We are quite familiar with super-cooled water drops which have been formed when liquid drops are cooled from temperatures above to temperatures below the freezing point. In this case there was no part of the atmosphere within hundreds of miles of the place of observation in which the temperature was above the freezing point, and almost a dead calm existed at the time; hence these drops could not have formed at a high temperature and then been super-cooled.

The only explanation which appears possible to me is that in the clear air of the Antarctic there are no "dust" particles suitable for condensation available, but there are plenty of the hygroscopic molecules of which we have already spoken. With increasing humidity these hygroscopic molecules attract water from the air and form clusters of water molecules; but we know from colloidal chemistry that such clusters are in the spheroidal and not in the crystalline form. If this explanation is correct we have real liquid drops and the vapour pressure in the air must be that appropriate to a water surface—we may neglect the curvature of the drops, as their radii were probably of the order of 0·001 cm. But according to Table II. air at $-30°$ C. is saturated with reference to ice at a relative humidity of 74 per cent., hence in this case the air was heavily supersaturated with reference to the solid state. This accounts for the fact, recorded at the time, that "the fur of the sleeping-bags and the wool of sweaters became covered with hoar frost," for these substances formed excellent nuclei for the condensation of the water vapour direct into the solid state.

Support for this explanation is given by observations made by Wegener in Greenland. He describes how, in temperatures below $-40°$ C. with perfectly clear air, a strip of fog started at the house and extended for several kilometres in the direction of the wind. At such temperatures condensation takes place on water at 100 per cent. relative humidity, but on ice or solid nuclei at 67 per cent. The actual humidity was between these limits, therefore the air was not saturated with reference to the hygroscopic nuclei, but was supersaturated with reference to solid nuclei. There were, however, none of the latter present in the pure free air, but the air escaping from the hut was highly charged with solid nuclei, chiefly the products of combustion, and when this contaminated air mixed with the pure air condensation took place and the long strip of mist resulted.

This observation furnishes the explanation of an old-standing difficulty in meteorological optics. Cirrus and other very high clouds frequently exhibit a most beautiful colour effect, which has received the name iridescent clouds, as the clouds appear to be iridescent with colours like those of mother-of-pearl. If cirrus clouds are always composed of ice particles, as one has generally concluded on account of the low temperature of the atmosphere where they form, the colours cannot be satisfactorily explained; but if they are composed of water drops the explanation is easy. If water drops can exist at $-30°$ C. near the earth's surface, there is no longer any reason to postulate ice crystals for the cirrus clouds; and we may now say definitely that iridescent clouds prove that cirrus clouds are sometimes composed of spherical water drops. But it also proves that air, especially in the upper atmosphere, is frequently devoid of solid nuclei on which condensation can take place.

Haze.—Perfectly pure air is almost completely transparent to visual light waves, and if the air were always pure we should see distant objects through air almost as clearly as through a vacuum. But the air is never pure; there are always more or less particles of foreign matter present. The action of these particles is two-fold: first, they reduce the amount of light reaching the eye from distant objects; and, secondly, in the day-time they scatter the general light of the sky and so send to the eye extraneous light which reduces the contrast between distant light and dark objects on which visibility depends. Generally this foreign matter consists of a mixture of solid ponderable particles and hygroscopic molecules. The latter in perfectly dry air would be practically invisible, but when loaded with water in a humid atmosphere they add to the obscurity of the atmosphere.

The amount of obscurity will therefore vary with the amount of solid matter and with the humidity of the air. Haze is due to this kind of obscurity, and varies in intensity from the slight obscurity of polar regions, which depends almost entirely on the hygroscopic particles, to the dense obscurity of a dust storm in tropical regions, which is due almost entirely to solid particles.

Mist.—When the temperature of air falls, the humidity increases until the saturation point is reached. The diameters of the hygroscopic particles grow, but even in saturated air the amount of water extracted is not great, and if there is little solid matter present the obscurity is not marked. But if the temperature falls below the dew point the hygroscopic particles are sufficiently large to form excellent nuclei for condensation, and relatively large amounts of water are deposited for small falls of temperature.

Real condensation has now commenced, and the obscurity changes from that of haze to that of mist. It has been a common practice to record atmospheric obscurity as haze when there is a noticeable difference between the readings of the wet- and dry-bulb thermometers, and as mist when the readings are the same. This, however, is not a true criterion, for the air can be saturated without condensation, while mist cannot be formed until water has been condensed on account of a fall of temperature after the dew point has been reached. The whole process of the formation of haze and mist is continuous, and in practice it is practically impossible to say when haze becomes mist, although extreme cases are easily distinguished. Nevertheless haze and mist are fundamentally different, for haze owes its origin to foreign matter, and the small amount of water associated with hygroscopic nuclei, while mist is due to an actual precipitation of water from vapour to liquid.

Fog.—There is, however, no fundamental difference between mist and fog: in most cases fog is only a dense mist, and the density at which mist becomes fog is a matter of definition. It is now the practice of the London Meteorological Office to limit fog to the obscurity in which objects at one kilometre are not visible.

When mist and fog are formed in fairly clear air they are white. On the other hand, if the air contains a large quantity of impurities, such as carbon particles from imperfect combustion, the mist particles absorb the impurities and become themselves dark-coloured. In this way are formed those dense fogs in London which are likened to pea soup. It was originally thought that the density of a London fog was due to the fact that the smoke of the city provided an unusually large number of nuclei on which condensation could take place, thus offering a temptation to the air to deposit its moisture which it could not resist. As a matter of fact, there are always sufficient nuclei in the purest air in England to allow of the formation of fog whenever the meteorological conditions are suitable. The relationship between smoke and fog is peculiar, and may be said to be accidental. The meteorological conditions which are necessary for the formation of fog are such that while they last smoke cannot get away either vertically or horizontally from the place of its origin. Above the fog there is a temperature inversion which effectively prevents all upward motion of either air or smoke, while fogs over the land usually form in calm air. Thus during a fog practically all the smoke which London makes is kept over it and within a few hundred feet of the ground. This smoke, combined with the deposited water, can, as we all know, produce such an obscurity that midday is as dark as midnight. The total abolition of smoke from London would not reduce the occasions on which mist and fog occur, but many fogs would remain mists, and we should never have a "London particular."

For the formation of mist and fog it is necessary that the temperature of the air should continue to fall after the dew point of the air has been reached. The extent of the fall below the original dew point determines the density of the obscurity, neglecting for the moment the effect of impurities. This cooling can be brought about in several ways, of which only two are of real importance. Fogs may be caused by warm air blowing over a cold sea or a cold land surface, and the method by which the temperature of the air is then reduced on account of turbulence was first explained in a brilliant paper by G. I. Taylor, which has become a meteorological classic. The fogs of London are, however, almost entirely due to the loss of heat from the lower layers of the atmosphere into a clear sky above. The air radiates its heat, its temperature falls, and condensation takes place as already described. Other methods of fog formation, such as the mixing of warm and cold air, are of secondary importance and never give rise to more than patchy local mists or light fogs.

Clouds.—Adiabatic cooling plays no part in the formation of mists and fogs, because the pressure changes in any given layer of the atmosphere are relatively small and slow. Appreciable adiabatic cooling can take place only when air is raised in the atmosphere, and then the cooling may be large and rapid.

When air not saturated rises in the atmosphere its temperature is reduced by about 1° C. for every 100 metres of ascent. When the ascent is carried far enough the dew point is reached, after which any further rise will cause condensation on the nuclei present. As the ascent is carried beyond the point of condensation more and more water is deposited, with a consequent increase in the size of the drops. This is the manner in which clouds are formed, and there are very good reasons for saying that it is the only way. Thus there is a fundamental difference between the method of formation of clouds and fogs: fogs form without any ascent of the air, while clouds are never formed without it. Thus it is not correct to describe clouds as fogs of the upper atmosphere.

The very sharp line of demarcation between the air under a cloud and the cloud itself needs explanation. There is no slow transition between the clear air and the cloudy air, as one would expect if clouds were due to the gradual increase in the size of drops from small nuclei to relatively large cloud particles. We must picture the hygroscopic nuclei collecting more and more water around them as they rise with the ascending current, owing to the increase in relative humidity. But when saturation is reached they are still very small, say about $1 \cdot 1 \times 10^{-5}$ cm., that is, they are smaller than the wave lengths of light (5×10^{-5} cm.), and therefore cannot be directly observed, and produce little obscurity in the air, which still appears relatively clear. Drops of this size need supersaturation to grow, but we see from Table I. that only 1 per cent. supersaturation is necessary. They are, however, unstable, for as they grow they need less supersaturation. Thus as soon as the air is sufficiently supersaturated to be in equilibrium with the nuclei the slightest further rise causes the drops to grow very rapidly to the size in which they are in equilibrium with saturated air. The height at which this change occurs is the height of the base of the cloud.

Rain.—Before we are able to form a clear idea of the processes which give rise to rainfall it will be necessary to consider the laws of the fall of water drops through the air.

It is well known that in a vacuum all bodies fall at the same rate with a constant acceleration, so that their velocity constantly increases. When, however, bodies fall through a resisting medium, such as air, they more or less quickly reach such a velocity that the resistance of the air equals the pull of gravity, after which they fall with a constant velocity, which is different according to the density and shape of the falling bodies.

Experiments have been made to determine the rate of fall of water drops through air at atmospheric pressure, and the following "end velocities" have been found.

Table IV.

Radius, cm.	Velocity calculated by Stokes, cm./sec.	Velocity observed by Schmidt, cm./sec.	Velocity observed by Lenard, cm. sec.
0·0005	0·3	..	..
0·001	1·3	..	..
0·005	32	..	..
0·010	126	..	..
0·020	..	180	..
0·030	..	270	..
0·040	..	340	..
0·050	..	393	440
0·100	..	577	590
0·150	..	692	690
0·175	..	740	737
0·225	..	..	805
0·273	..	..	798
0·318	..	..	780

Three important points are to be noticed about these results.

(*a*) The extremely small velocities with which small drops fall. The average radius of the drops in clouds from which rain is not falling is approximately 0·001 cm. Such particles, according to our table, would fall only at the rate of a little over a centimetre a second.

(*b*) As the drops get larger the rate of fall tends to a constant value of about 8 metres a second.

(*c*) Drops for which $r = 0{\cdot}25$ cm. have the most rapid fall, larger drops fall more slowly.

Lenard has given the reason for (*c*). He showed that the friction on the air causes deformation of the drops, so that instead of retaining the shape of spheres they become flattened out, thus presenting an increased resistance to the air through which they are falling. This deformation becomes appreciable when the radius of a drop is about 0·2 cm. and then increases rapidly as the drop grows larger. When the radius is about 0·25 cm. and the drop is falling at the rate of 8 metres a second, any further increase in volume produces a greater flattening, and instead of the velocity being increased it is slightly decreased. When the size of the drop is such that if it were not flattened it would have a diameter of about half a centimetre, $r = 0{\cdot}25$ cm., the drop becomes very unstable, and all drops larger than this quickly break up into a number of smaller drops, which of course fall more slowly. This means that raindrops can never fall through air at a greater velocity than 8 metres a second. Small drops fall slower than this, and large drops flatten out as soon as they are falling at 8 metres a second, and then soon break up into smaller drops.

In the above all the velocities have been given for air at normal pressure. If, however, the pressure is less, all the results are the same, except that the velocities must be increased in the proportion $\sqrt{B}/\sqrt{P}$, in which B is the normal pressure and P the actual pressure.

Dines has found that in Europe the quantity of vapour in air is always very small. If the whole water vapour in the atmosphere on an average summer day were precipitated it would only give a total rainfall of 0·80 in. The greatest amount ever measured on a summer day in Europe would only give 1·5 in. of rain, and of course the quantity is much less in winter. How then can we have rainfall of several inches of rain in the course of an hour or so? The answer is simple: the ascending currents which are necessary to cause precipitation carry with them their own water vapour to supply the rainfall. An ascending current of air which is saturated at 10° C. (50° F.) needs only an upward velocity of 1 metre a second to carry with it sufficient vapour to give a rainfall of more than 1 inch per hour, so that there is no difficulty in explaining the greatest rate of rainfall ever experienced in the tropics.

There are many ways in which the air is caused to rise in the atmosphere; ascending currents up to many metres a second are possible, and do occur in the atmosphere. Let us think of air rising at about 10 cm. per second, which is the order of the upward velocity of the air in depressions. At a certain height cloud particles form as already described. These have a radius of about 0·001 cm. and fall relatively to the air at 1·3 cm. per sec., hence they are carried upwards with the air, but the base of the cloud remains at the same height because new cloud particles are constantly being formed at that height. As the air rises the cloud particles grow in size, because water is being condensed on them, and they lag more and more behind the air. Drops with a radius of 0·002 cm. are falling as rapidly as the air is rising, and therefore remain stationary, while drops of 0·007 cm. are falling at the rate of one metre a second, and therefore fall through the rising air and appear at the earth's surface as rain. It is obvious that this process will continue as long as the ascending currents continue, and in this way we get the continuous steady rain with which we are so familiar in this country.

The rate of rainfall will increase as the upward velocity of the ascending air increases until the upward velocity becomes greater than 8 metres a second. When this occurs no water can fall through the ascending air for the reason already explained. All water condensed in such an upward current—and it will be a very large amount—is carried upwards until the upward air velocity falls below 8 metres a second, as it is bound to do at some height owing to lateral spreading out. Here water accumulates in large amounts. It is the sudden cessation of the upward velocity in such an ascending current which gives rise to the so-called cloud-bursts, for when the sustaining current stops the accumulated water falls just as though the cloud had literally burst.

The accumulated water while it is suspended in the air is constantly going through the process of coalescing into large drops, which at once become deformed and broken up again into small drops. Every time a drop breaks there is a separation of electricity, and this is probably the chief source of electricity in a thunderstorm. This explains why thunder-storms are associated with heavy rainfall and do not occur in polar regions where there is no rain.

Hail.—I have already explained how the small liquid cloud particles are carried upwards with the ascending air, but as the air rises its temperature constantly falls, and there must come a point in the ascent when the temperature falls below the freezing point. The cloud particles do not immediately turn into ice. As a matter of fact it is not an easy matter to freeze perfectly pure water, and water can remain liquid at temperatures far below the freezing point. Observations made on mountains and in balloons and aeroplanes have proved conclusively that cloud particles remain liquid at temperatures so low as −20° C. How far small drops can be super-cooled before they solidify we do not know, but super-cooled drops are in a very unstable state. From Table II. we see that at −20° C.

ice forms when the relative humidity over water is 82 per cent., which means that if water and ice are simultaneously present the relative humidity of the air relative to the ice is 121 per cent., *i.e.* it is 21 per cent. supersaturated. Thus if a few drops become converted into ice they are in a highly supersaturated atmosphere, and so will grow rapidly at the expense of the water drops. Meteorologists generally consider that $-20°$ C. is about the limit at which large water particles can exist without changing into ice.

Let us consider a region in the atmosphere through which there is an ascending current of air. The air is supposed to have a temperature of 20° C., and a relative humidity of about 50 per cent. at the ground. As the air rises, at first its temperature is reduced by 1° C. for each 100 metres of ascent. Hence by the time it has risen 1000 metres its temperature will have been reduced to 10° C., and it will have reached its dew point. Here the cloud level begins. As it rises still further its temperature continues to decrease, but not so rapidly as before, because the condensation of water vapour releases the latent heat of vaporisation. It reaches 0° C. at a height of 3000 metres. Hence the region between 1000 and 3000 metres contains only drops of water. As the air rises above 3000 metres the temperature falls still lower, but the water particles do not freeze at once, they remain super-cooled. We may assume that at $-20°$ C., which is reached at about 6000 metres, the super-cooled drops solidify and the remaining part of the cloud above this level is composed of snow alone.

There will not be a sharp division between the region of super-cooled water and the region of snow. For a certain distance ice crystals and super-cooled water will be mixed together. Such conditions are very unstable, and from considerations of the vapour pressure alone the ice particles grow rapidly, because the vapour over super-cooled water is highly supersaturated with respect to ice. In addition, the slightest contact between ice and super-cooled water causes the latter to solidify at once. The original ice particle will therefore quickly grow in size and, if the ascending current is not too large, will commence to fall. It has, however, to fall through 3000 metres of super-cooled water drops, and in doing so grows appreciably in size. As each super-cooled water particle strikes the ice it solidifies, and also imprisons a certain amount of air, so that by the time the ice particle reaches the bottom of the super-cooled region it is simply a ball of soft white ice without any sign of regular crystalline structure.

If the descent through the super-cooled region has been fairly rapid the temperature of the ice ball will be considerably below the freezing point when it arrives in the region where the temperature is 0° C., and the cloud particles are not super-cooled. As it continues its way downwards it receives a considerable addition of water: in the first place, by direct deposition, because it is colder than the air; and, secondly, by collision with the water particles. This water covers the surface of the cold ice ball with a uniform layer of liquid which quickly freezes into clear solid ice, with little or no imprisoned air. Finally the ice escapes from the bottom of the cloud, and falls to the ground as a hailstone.

When hailstones are split open to show their internal structure we can nearly always see the inner soft white mass of ice which was collected while the stones were in the super-cooled region, surrounded by a layer of clear transparent ice formed by the freezing of the water deposited when the stone was passing through the non-super-cooled region.

This simple explanation of the formation of a hailstone was not considered satisfactory at first, because it was considered that hailstones produced in this way must necessarily be small. Trabert calculated that if a hailstone started to fall from a height of 2 kilometres, and swept up all the water it met on its way down, its radius would grow only by 2 millimetres. But Trabert left many things out of consideration, as pointed out by Wegener. In the first place, he started his hailstone much too low in the atmosphere: he should have started it from a height nearer 8 kilometres than 2. Secondly, he neglected the effect of the ascending currents. We know that there are violent ascending currents during thunder-storms, in which alone hailstones are formed. The ascending currents may be so violent that even large hailstones will not be able to fall through them, but they are all the time falling rapidly relatively to the air, and therefore sweeping water out of it.

The velocity with which a hailstone falls through still air at atmospheric pressure is

$$v = 1246\sqrt{r} \text{ cm./sec.}$$

If, therefore, the velocity of the ascending current were 10 metres per second, the hailstone could not commence to fall until it had a radius of 0·64 cm. It would then commence to fall very slowly as its size grew larger, but it would all the time be moving relatively to the air at a greater rate than 10 metres a second. Thus the effective height through which it would fall would be very great in comparison with the actual height.

It must also be remembered that with such an ascending current no water could fall in the form of rain; all the water would be retained in the cloud, the water content of which could be very large indeed, thus giving large quantities of water to be swept up by the hailstone. When we also take into account that a hailstone is generally very much colder than the surrounding saturated air, so that the deposition of moisture on it from the vapour would be large, there is no difficulty in explaining the size of all ordinary hailstones.

It must not be considered, however, that an ascending current is steady. Just as we have gusts and lulls in horizontal winds, so we have increases and decreases in the velocity of ascending currents. Thus a hailstone which has penetrated into the lower part of the cloud might be blown upwards and so go through the whole process again. In this case we should have a layer of white ice deposited around the clear layer, around which again there would be another layer of clear ice. In fact, if a hailstone is held by the ascending currents near to the region where the temperature is 0° C., it might well be carried up and down between the regions where the water is super-cooled and where it is not several times. We should then have several concentric layers of clear and white ice, and a broken stone would have the appearance of an onion. Such cases are not at all uncommon.

For the formation of hailstones two conditions must be fulfilled.

(*a*) The clouds must extend through a great vertical height so that the three regions of water particles, super-cooled particles, and snow are extensive and well developed.

(*b*) There must be violent ascending currents, otherwise the stones would fall too rapidly to grow to a large size.

These conditions are best fulfilled in warm regions, for there violent ascending currents are most easily developed, and the condensation starts at a relatively high temperature, so giving regions of water particles and super-cooled water particles of great depth. These are the reasons why hailstones only occur during the summer in temperate regions, and why the most violent hailstorms and the largest hailstones are found in tropical regions.

Soft Hail.—If the temperature at the ground were much lower than in the case just considered, the region between the bottom of the cloud layer and the zero isothermal would be much reduced. It is in this region that the hailstone receives its coat of clear transparent ice. The hailstones which then fall would be relatively small, and consist only of the soft white balls appearing in the centre of the more complete hailstones.

Falls of soft hail of this nature are quite common in the winter in Europe and in the hills of India; there are frequently falls of soft hail during the winter and spring in Simla. The reason is clear, for in Europe the temperature of the ascending current is so low that the freezing point is reached almost at the bottom of the cloud, while in Simla the clouds form over the plains, and Simla itself is so high that the region in which water particles exist is mainly below the station. Thus the hail which falls in Europe during the winter and in the hills of India falls almost immediately out of the region of super-cooled water particles, and therefore has had no opportunity for building up a layer of transparent ice.

The form of these soft hailstones is most instructive. In most cases they are like cones with a hemispherical base. It is clear from this form that as they have fallen through the super-cooled region they have struck the water particles on their under sides. This has caused the bases to grow, and the cone above is really the shape of the stream-lines behind the enlarged base. A stone which has once commenced to have this form will retain it throughout, for the cone acts as a kind of tail and tends to keep the base always at right angles to the relative air motion.

Snow.—Snow which forms over an ascending air current in which water particles first form will probably have solidified cloud particles for nuclei. Whatever the nuclei may be, as soon as the initial crystals are formed further condensation takes place exactly as in the precipitation of water, but the vapour condenses directly into the solid state without first going through the liquid state. The crystals of water are hexagonal prisms, and water in the crystalline state in the atmosphere shows all the wonderful shapes that this form of crystallisation can take. Having once started, the crystals may grow either along their central axis, giving rise to long thin prisms, or along their six axes to form hexagonal plates.

Sometimes the growth is uniform, so that the result is a perfect hexagonal plate, at others the growth along the axes is more rapid than in the space between; this gives rise to stars, having a beautiful feathery appearance. The actual crystals vary in size, from minute crystals which can scarcely be seen by the naked eye to plates a quarter of an inch in diameter. In cold regions the crystals are small, because there is little water vapour present from which they can grow. In the Antarctic during the winter, when the temperature was always near or below 0° F., only the smallest crystals were seen, so small that they were almost like dust.

When crystals form at temperatures near the freezing point they grow to their largest size. When the air is full of large crystals frequent collisions take place. The crystals become interlocked and bundles of many separate crystals are formed; these produce the ordinary snowflakes which, on account of their size and weight, fall relatively rapidly. It is to these latter that the term snow should be applied. With this restriction, snow occurs only when the temperature is near the freezing point.

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The Interior of a Star.[1]

By Prof. A. S. Eddington, F.R.S.

On December 13, 1920, the angular diameter of a star was measured for the first time in history with an apparatus devised by Prof. A. A. Michelson. Hitherto every star had appeared as a mere point of light, and no test had been able to differentiate it from a geometrical point. But on that eventful evening a 20-foot interferometer constructed at the Mt. Wilson Observatory was turned on the star Betelgeuse, and the measurement revealed that this star had a disc $\frac{1}{20}$ of a second of arc in diameter—about the size of a halfpenny 50 miles away. The distance of Betelgeuse is known roughly (unfortunately it cannot be found so accurately as the distances of many stars), so that we can convert this apparent size into approximate actual size. Betelgeuse is not less than 200 million miles in diameter. The orbit of the earth could be placed entirely inside it.

The stars are thus not limited to objects of comparatively small bulk like the sun; there are among them individuals truly gigantic in comparison. We can add another step to the astronomical multiplication table—a million earths make one sun; ten million suns make one Betelgeuse. This is a comparison of volume, not of amount of material. It leaves open the question whether, in order to obtain one of these giants, we should take the material of ten million suns rolled into one, or whether we should take the material of the sun and inflate it to ten million times its present size. There is no doubt that the latter answer is nearer the truth. Betelgeuse, I admit, contains more matter than the sun (perhaps 50 times as much); but in the main its vast bulk is due to the diffuseness with which this material is spread out. It is a great balloon of low density, much more tenuous than air, whereas in the sun the material is compressed to a density greater than water.

Whether the star is one of these balloon-like bodies or whether it is dense like the sun depends on the stage of its life at which we catch it. It is natural to think that the stars gradually condense out of diffuse material, so that they become denser and denser as their life-history proceeds. We can now see in the heavens samples of every stage in the development of a star. The majority of those seen with the naked eye are in the early diffuse state; that is not because these young stars are really more numerous, but because their great bulk renders them brighter and more conspicuous. What I shall have to say about the inside of a star refers chiefly to the young diffuse stars—the *giant stars* as they are called. The reason is that we understand much more about the properties of matter when it is in the condition of a perfect gas than when it is condensed; although the difficulties of treating a dense star like the sun are not insuperable, we have naturally made the most progress with the easier problem of giant stars.

Internal Temperatures.

We only observe the physical conditions at the surface of a star, and at first it might seem impossible to learn anything about the conditions in the interior. Consider, for example, the question of temperature. The nature of the light received from Betelgeuse teaches us that the temperature is 3000° C.—not an extravagantly high temperature judged even by terrestrial standards. But this refers, of course, to the layer near the surface from which the observed light is coming; it is just the marginal temperature of the furnace affording no idea of the terrific heat within. I shall not attempt to explain in detail how we manage to calculate the inside temperatures; but I can perhaps show that there is a clue which can be followed up by appropriate mathematical methods.

Elasticity is a well-known property of a gas, familiar to everybody through its practical application in the pneumatic tyre. What gives the gas its elasticity or expansive force is its heat, that is to say, the energy of motion of its molecules hastening in all directions and continually tending to spread apart. The greater the heat the greater the expansive force. Now at any point inside the star a certain condition of balance must be reached; on one hand we have the weight of all the layers above pressing down and trying to squeeze closer the gas inside; on the other hand we have the elasticity of this inside gas trying to expand and force the upper layers outwards. Since neither one thing nor the other happens and the star remains practically unchanged for hundreds of years, we must conclude that these two tendencies just balance. At each point the elasticity and therefore the heat has to be of the exact amount needed to bear the weight of the layers above. That is the principal clue by which we determine how much heat there must be at various depths inside the star.

The internal temperature depends on the particular star considered, but it is generally from 2 to 20 million degrees at the centre. Do not imagine that this is a degree of heat so vast that ordinary conceptions of temperature have broken down. These temperatures are to be taken quite literally. Temperature is a mode of describing the speed of motion of the ultimate

[1] Discourse delivered at the Royal Institution on February 23.

particles of the matter. In a mass of helium at ordinary temperatures the average speed of the atoms is rather less than 1 mile per second; at 4 million degrees it is 100 miles per second. This is a high speed, but not a speed to feel uncomfortable over. Sir Ernest Rutherford describes atoms of helium moving at the rate of 100,000 miles a second. I cannot vie with him. I usually find that my physical colleagues are rather disappointed with our jog-trot atoms in the stars.

Material and Ætherial Heat.

We must imagine then a typical giant star as a mass of material with average density about that of air swollen to at least a thousand times the bulk of the sun. The atoms of which it consists are rushing in all directions with speeds up to 100 miles a second, continually colliding and changing their courses. Each atom is being continually pulled inwards by the gravitation of the whole mass, and as continually boosted out again by collision with atoms below. The energy of this atomic motion constitutes a great store of heat contained in the star; but this is only part of the store. The star contains a store of another kind of heat—ætherial heat, or æther-waves like those which bring to us the sun's heat across 90 million miles of vacant space. These waves also are hastening in all directions inside the star. They are encaged by the material, which prevents them leaking into outer space except at a slow rate. An æther-wave making for freedom is caught and absorbed by an atom, flung out in a new direction, and passed from atom to atom; it may thread the maze for hundreds of years until by accident it finds itself at the star's surface, free now to travel through space indefinitely, or until it ultimately reaches some distant world, and perchance entering the eye of an astronomer, makes known to him that a star is shining.

The possession of this double store of heat is a condition which we do not encounter in any of the hot bodies more familiar to us. It is a new phase of matter beyond the reach of laboratory experiment, although happily the theory is so simple that there cannot be much uncertainty as to behaviour. It is true that a red-hot mass of iron contains a little of this ætherial heat in addition to the heat comprised in the motion of its molecules, but it is less than a billionth part of the whole. Only in the giant stars does the ætherial portion rise to importance. A red-hot metal emits ætherial heat, but it keeps no appreciable store; it converts the material heat into this form as it is required for use. The star rejects this hand-to-mouth method; and although it is continually changing elements of heat from one form to the other, it keeps a thousand years' supply always in readiness and emits its radiation by leaking ætherial heat from the store. In older theories this feature was not realised; it was supposed that convection currents must exist continually bringing up hot matter from the interior to replace the surface-matter which had radiated and cooled. Now it is seen that the difficulty is rather in the other direction—how does the star dam back the store of æther-waves so that they do not escape from it faster than we observe? This change of view has necessitated modifications of the older theories of Lane and others, and has on the whole considerably simplified the problem.

In the hot bodies of the laboratory the heat is almost entirely in the material form, the ætherial portion being insignificant. In the giant stars the heat is divided between the two forms in roughly equal amounts. Can we not imagine a third condition in which this time the heat is almost wholly ætherial, the material portion being insignificant? We can imagine it, no doubt; but the interesting, and I believe significant, thing is that we do not find it in Nature.

Light Pressure.

You have heard of the pressure of light—that light actually has mass and weight and momentum and exerts a minute pressure on any object which obstructs it. A beam of light or æther-waves is like a wind, a very minute wind as a rule; but the intense ætherial energy inside the star makes a strong wind. This wind distends the star. It bears to some extent the weight of the layers overhead, leaving less for the elasticity of the gas to bear. That, of course, has to be taken into account in our calculation of the internal temperatures—making them lower than the older theory supposed. Just as æther and matter share the heat-energy between them, so the ætherial wind and the material elasticity share the burden of supporting the weight of the layers above. We are able to calculate the proportions in which they share it. To a first approximation the same proportion holds throughout nearly the whole interior, and the proportion depends only on the total mass of the star—not on the density or even on the chemical composition of the material. Moreover, in order to make this calculation we do not need any astronomical knowledge; all the constants in the formula have been determined by the physicist in his laboratory. We need to know the average molecular weight of the material, but I shall tell you later how we are able to fix that approximately in spite of not knowing what elements to expect in the star's interior; that happens to be one of the benefits of dealing with very high temperatures.

Let us imagine a physicist on a cloud-bound planet, who has never heard tell of the stars, setting to work to make these calculations for globes of gas of various dimensions. Let him start with a globe containing 10 grams, then 100 grams, 1000 grams, and so on, so that his *n*th globe contains 10^n grams. They mount up in size rather rapidly. No. 1 is about the weight of a letter; No. 5, a man; No. 8, an airship; No. 10, an ocean liner; after that comparisons are difficult to find. The following table gives part of his results:

No. of Globe.	Ætherial Pressure.	Material Pressure.
30	0·00000016	0·99999984
31	0·000016	0·999984
32	0·0016	0·9984
33	0·106	0·894
34	0·570	0·430
35	0·850	0·150
36	0·951	0·049
37	0·984	0·016
38	0·9951	0·0049
39	0·9984	0·0016
40	0·99951	0·00049

It is obvious why I omit the rest of the table; it consists of long strings of 0's and 9's. But for the 33rd, 34th, and 35th globes the table becomes interesting; and then lapses back into 9's and 0's again. Regarded as a tussle between æther and matter to control the situation, the contest is too one-sided to be interesting, except just from Nos. 33 to 35, where something more exciting may be expected.

Now let us draw aside the veil of cloud behind which our physicist has been working and let him look up into the skies. He will find there a thousand million globes of gas all of mass between the 33rd and 35th globes. The lightest known star comes just below the 33rd globe; the heaviest known star is just beyond the 35th globe. The vast majority are between Nos. 33 and 34. just where the ætherial pressure begins to be an important factor in the situation.

It is a remarkable fact that the matter of the universe has aggregated primarily into units of nearly constant mass. The stars differ from one another in brightness, density, temperature, etc., very widely; but they all contain, roughly, the same amount of material. With a few exceptions they range from ½ to 5 times the mass of the sun. I think we can no longer be in serious doubt as to the general cause of this, although the details of the explanation may be difficult. Gravitation is the force which condenses matter; it would if unresisted draw more and more matter together, building globes of enormous size. Against this, ætherial pressure is the main disruptive force (doubtless assisted by the centrifugal force of the star's rotation); its function is to prevent the accumulation of large masses. But this resistance, as we see, only begins to be serious when the mass has already nearly reached the 33rd globe; and if indeed it is efficacious, it will stop the accumulation before the 35th globe is reached, because by then it has practically completely ousted its more passive partner (material pressure). We do not need to know exactly how strong the resistance must be in order to prevent the accumulation, because, when once the resistance begins to be appreciable, it increases very rapidly and will very soon reach whatever value is required. All over the universe the masses of the stars bear witness that the gravitational aggregation proceeded just to the point at which the opposing force was called into play and became too strong for it.

Ascending and Descending Temperature Stages.

It was shown by Homer Lane in 1870 that as a gaseous star contracts its temperature will rise. Betelgeuse is typical of the first stage when the temperature has risen just far enough for the star to be luminous. It will go on contracting and becoming hotter, its light changing from red to yellow and then to white. But evidently this cannot go on indefinitely. When the condensation has proceeded far enough the material will be too dense to follow the laws of a perfect gas. A different law then begins to take control. The rise of temperature becomes less rapid, is checked, and finally the temperature falls. We can calculate that the greatest temperature is reached at a density of about ¼ to ⅓ that of water. The sun is denser than water, so that it has passed the summit and is in the stage of falling temperature. So long as the temperature is rising the brightness of the star scarcely changes. It is becoming hotter, but smaller. Calculation shows that the increased output of light and heat per square metre of surface, and the decreased area of the surface, very nearly counteract one another, so that the total output remains fairly steady. But on the downward path the falling temperature and diminishing surface both reduce the light, which falls off rapidly between the successive stages or types which we recognise. That is entirely in accordance with what is observed to happen.

Taking any level of temperature, a star will pass through it twice, once ascending and once descending. In the main we have been in the habit of classifying stars according to their surface temperature, because it is on this that the spectral characteristics of the light, its colour, and the chemical elements revealed, chiefly depend. But that classification mixes together stars from an early ascending stage and from a later descending stage. For example, a star like Betelgeuse just beginning its career is put in the same class with a dense red star which has run its course and reached its second childhood. They are both red stars of low temperature, and that was good enough for the early attempts at classification. Sir Norman Lockyer always stoutly maintained the existence of the ascending and descending series; but he was almost alone among spectroscopists in this. He did not actually succeed in separating the ascending and descending stars though sometimes he came very near to the right criterion. We owe to Russell and Hertzsprung the actual separation. They discovered it not by spectroscopy, but by measuring the absolute brightness of stars; the greater brightness of the ascending stars, due to their large bulk, easily distinguishes them from the descending stars, at any rate in the low-temperature groups. At the highest temperatures the two series merge into one another.

The disentangling of the two series, and the recognition of the true sequence of stellar evolution, is probably the most revolutionary and far-reaching of recent discoveries in stellar physics. It began to oust the older view about 1914, and it is worth noticing that the discovery was made from observations coming under the province of the older astronomy and not what is generally called astrophysics. The data were parallaxes, proper motions, double star orbits, etc. The spectroscopists had been misled as to the order of evolution, and it was left to the rival branch of astronomy to show the way; but they were not to be outdone for long. Adams and Kohlschütter have found an easy spectroscopic method for distinguishing the ascending and descending stars. Although our main purpose now is to grope in the interior of a star, perhaps we may emerge at the surface for a moment to consider what is the difference of surface condition of a diffuse and condensed star, respectively, which enables the spectroscope to distinguish between them.

Surface Conditions.

The state of the outermost layers of a star can, it would seem, be influenced by two factors only, (1) the intensity of the stream of radiant energy crossing through them and (2) the intensity of gravitational attraction holding them to the star. The former is measured by the effective temperature, so that we have the two variable factors, temperature and gravity. The spectrum presumably will vary as the conditions governed by these factors vary. We must not expect to be able to classify the spectra accurately in a single sequence; they can vary in two directions. The ordinary classification depends principally on the temperature factor; we may call this the longitudinal sequence. Adams's new method aims at disentangling the transverse sequence corresponding principally to the gravity factor. We may say that his method is really a way of finding the value of gravity at the surface of a star, although it is not yet possible to put the value into actual numbers. Clearly, gravity will be smaller in the diffuse stage than in the dense stage on account of the greater distance from the centre to the surface.

The effect of lowering gravity is to make the density smaller at corresponding temperature. This introduces an important change in the state of the gas, namely, ionisation. At moderately high temperatures the atoms begin to lose one or more of their most loosely attached electrons, a process called ionisation. Ionisation is facilitated by low density and prevented by high density. The theory of ionisation in stellar atmospheres has been chiefly worked out by M. N. Saha, who has arrived at many interesting results. Here we need only remark that the ionised atoms give rise to different spectra, which have long been distinguished from the spectra of the neutral atoms. The lower density in the atmosphere of diffuse stars should strengthen the "enhanced" lines due to ionised atoms, compared with the "arc" lines due to neutral atoms. The difference in general is not very large, but the atoms of certain elements for which the conditions are most critical, are specially sensitive to the change of density. This is the criterion which Adams and Kohlschütter found empirically, and it distinguishes quite easily the ascending and descending series. To a limited extent it also distinguishes the larger and smaller stars within the same series.

Although the stars begin to shine on reaching a temperature of about 3000° and return to this temperature at the close of their luminous existence, they do not all climb the temperature-ladder to the same height. The more massive stars climb higher than the light stars. We can to some extent calculate the height to which they will go; but I am afraid the figures at present are very uncertain, though there is hope of improving them before long. The sun's surface temperature is now about 5900°; I do not think that it ever went higher than 6600°; it had not sufficient mass to go beyond. Sirius, nearly 2½ times as massive as the sun, has climbed to 11,000°, and at the moment is practically at its maximum, having only just turned downward. Still hotter stars like Rigel are known, and these must be more massive still. At the other end of the scale a star of mass less than 1/7 of the sun would not be able to reach 3000°, and could scarcely be luminous; but in any case such small masses would be formed very seldom, for the reason explained earlier in this lecture. It is a well-known fact that hot stars on the average are more massive than cool stars; we see that this is accounted for by the smaller stars being weeded out as the temperature-standard is raised.

Atoms and Electrons.

We have hitherto pictured the inside of a star as a hurly-burly of atoms and æther-waves. We must now introduce a third population to join in the dance. There are vast numbers of free electrons—unattached units of negative electricity. More numerous than the atoms, the electrons dash about with a hundred-fold higher velocity—corresponding to their small mass, which is only 1/1850 of a hydrogen atom. These electrons have come out of the atoms, having broken loose at the high temperature here involved. An atom has been compared to a miniature solar system; a composite central nucleus carrying positive charge corresponds to the sun, and round it revolve in circular and elliptic orbits a number of negative electrons at comparatively large distances corresponding to the planets. We know the number of satellite electrons for each element; sodium has 11, iron 26, tin 50, uranium 92. Our own solar system with 8 revolving planets represents an atom of oxygen. The thermodynamical theory due mainly to Nernst permits us to calculate roughly how many of these break loose under given conditions of temperature and density; and in a typical star a large proportion of them must have become free.

This condition solves for us our chief difficulty as to the molecular weight of stellar material. We need to know it in order to perform our calculations as to the state of the star; and at first sight it might seem hopeless to arrive at the molecular weight without knowing the elements which constitute the bulk of the material. But suppose first that the temperature is so high that all the satellite electrons have broken away. An atom of sodium will have separated into 12 particles, namely, 11 electrons and 1 mutilated atom; its atomic weight 23 is divided between 12 independent particles, so that the average weight of each is $23/12 = 1{\cdot}92$. Next take iron: the atomic weight 56 is divided between 27 particles; average 2·07. For tin we have 119 divided by 51; average 2·34. For uranium, 238 divided by 93; average 2·56. It scarcely matters what element we take; the average weight of the ultimate particles (which is what we mean by the molecular weight) is always somewhere about 2. If only the stars were a bit hotter than they actually are, it would make our task very easy. Unfortunately, they are not hot enough to give complete separation, and the actual degree of separation will depend on the temperature of the star, thus introducing a difficult complication. Generally at least half the electrons are detached and the molecular weight must be taken as between 3 and 4. I hope that the theory of this dissociation of electrons will be improved, because at present it is the chief bar to rapid progress with the theory of stellar constitution. It is a great help to know that the molecular weight is between 3 and 4; but we have reached a stage when it is becoming necessary for progress to know it for each star within much closer limits.

Brightness and Mass.

We pictured a physicist on a cloud-bound planet who was able from laboratory data to predict how large would be the masses into which the material of the universe must aggregate. Let us now set him a harder task. We inform him that we have observed these masses of gas, and, choosing one equal, say, to his 34th sphere, we ask him to predict how brightly it will shine. I have already mentioned that the star keeps practically the same brightness so long as it is a perfect gas ascending in temperature, so it should not be necessary to give the physicist any data except the precise mass. To use the same plan as before, we imagine a series of lamps of 10 candle-power, 100 candle-power, 1000, and so on; and his task is to pick out which lamp in this series corresponds approximately to the star. I believe that it is now possible for him to perform this task and to pick out (correctly) the 31st lamp. But for this purpose it is not enough that he should know all about the heat stored in the interior of the star; the brightness of the star depends on the rate at which the æther-waves are leaking out, and that introduces a new subject—the obstructive power of the material atoms which dam back the radiant flow.

Another name for this obstructive power is *opacity*. A substance which strongly obstructs the passage of light and heat waves is said to be opaque. The rising temperature towards the centre of the star urges the heat to flow outwards to the lower temperature level; the opacity of the material hinders this flow. The struggle between these two factors decides how much light and heat will flow out. We have calculated the internal temperature-distribution, so that we know all about the first factor; if then we can observe the outward flow which occurs, that should settle the value of the second factor—the opacity. The outward flow is capable of observation because it constitutes the heat and light sent to us by the star.

One of the troubles of astronomy is that our information about the stars is so scattered. We know the mass of one star very accurately, but we do not know its absolute brightness; we know the brightness of another but not its mass; for a third we may have an accurate knowledge of the density but nothing else. For Sirius, Procyon, and α Centauri our knowledge is fairly complete and accurate; but not any of these are giant stars in the state of a perfect gas, and they are therefore useless for the present discussion. But within the last year we have been fortunate enough to obtain complete and very accurate information for one of the giant stars, Capella. This is another of the benefits which astronomy has derived from Prof. Michelson's interferometer method of observation. The brighter component of Capella (which is a double star) has a mass 4·2 times that of the sun and a luminosity 160 times greater. We can use these facts to calculate the opacity of Capella in the way I have described; it turns out to be 150 in C.G.S. units. To illustrate the meaning of this, let us enter Capella and find a region where the density is that of the terrestrial atmosphere we are accustomed to; a slab of this gas only 6 inches thick would form an almost opaque screen. Only $\frac{1}{20}$ of the radiant energy falling on one side would get through to the other, the rest being absorbed by the gas.

Absorption of X-rays in Stars.

It seems at first surprising that 6 inches of gas could stop the æther-waves so effectively; but we might have anticipated something like this from general physical knowledge. We give different names to æther-waves according to their wave-length. The longest are the Hertzian waves used in wireless telegraphy; then come the invisible heat-waves; then light-waves; then photographic or ultra-violet waves. Beyond these we have X-rays, and finally—the shortest of all—the γ-rays which are emitted by radioactive substances.

Where in this series are we to place the æther-waves in the interior of a star? It is solely a question of temperature, and the æther-waves at stellar temperatures are those which we call X-rays—more precisely, they are very "soft" X-rays. Now X-rays, and soft X-rays especially, are strongly absorbed by all substances. The opacity which we have found in Capella is of the same order of magnitude as the opacity of terrestrial substances to X-rays measured in the laboratory. The following table shows a few of the laboratory results compared with the astronomical value for Capella:

Wave-length (Å).	Absorption-coefficient (opacity) in			
	Aluminium.	Iron.	Silver.	Capella.
0·5	2	14	10	...
0·95	11	80	72	...
1·1	21	125	86	...
1·3	31	205	152	...
2·3	136	...	...	...
10	...	...	...	150

We have been performing an investigation of the absorption of X-rays in a star, parallel to investigations on the same subject made in the laboratory. In one respect the physicist has a big advantage because he can vary the material experimented on, whereas we have to be content with the material, whatever it is, composing the stars. But, as you see from the table, the physicist is also interested in finding how the absorption changes for different wave-lengths. We can follow him in this, and even do better than him, because he is restricted by certain practical difficulties to a narrow range of wave-length, whereas we can explore a range of wave-length covering a ratio of at least 10 to 1, by using stars of different temperatures. It is true that our results are not yet very accurate; we have only one star, Capella, for which a really good determination is possible, but for other stars rough values can be found. The terrestrial results indicate an extremely rapid change of absorption for slight alterations of wave-length (as is seen from the table); the astronomical results, on the contrary, give a nearly steady absorption-coefficient. We cannot yet detect certainly whether it increases or decreases with wave-length; at any rate there is nothing like the rapid change shown in the foregoing table. This profound discrepancy between astronomical and laboratory results leads us to inquire more deeply into the theory of absorption in a star. It will be found that there is a good reason for it.

We have been taking advantage over our cloud-bound physicist by having a preliminary peep at an actual star. We are not going to allow *him* to do that. He must not use astronomical observations to determine the opacity, but must be able to predict the astronomical value either from pure theory or from terrestrial experiments. This study is of special interest because it plunges us at once among those problems which are most exercising practical physicists at the present time. We started to explore the interior of a star; we shall presently find ourselves in the interior of an atom.

It is now generally agreed that when æther-waves fall on an atom they are not absorbed continuously. The atom lies quiet waiting its chance and then suddenly swallows a whole mouthful at once. The waves are done up in bundles called quanta and the atom has no option but to swallow the whole bundle or leave it alone. Generally the mouthful is too big for the atom's digestion, but the atom does not stop to consider that; it falls a victim to its own greed—in short, it bursts. One of its satellite electrons shoots away at high speed, carrying off the surplus energy which the atom was unable to hold. The bursting could not continue indefinitely unless there were some counter-process of repair. The ejected electrons travel about, meeting other atoms; after a time a burst atom meets a loose electron under suitable conditions and induces it to stay and heal the breach. The atom is now repaired and ready for another mouthful as soon as it gets the chance.

From this cause a big difference arises between absorption of X-rays in the laboratory and in the stars. In the laboratory the atoms are fed very slowly; the X-ray bundles which they feed on can be produced by us only in small quantities. Long before the atom has the chance of a second bite it is repaired and ready for it. But in the stars the intensity of the X-rays is enormous; the atoms are gorged and cannot take advantage of their abundant chances. The consumption of food by the hungry hunter is limited by his skill in trapping it; the consumption by the prosperous profiteer is limited by the strength of his digestion. Laboratory experiments test the atom's skill in catching food; stellar experiments test how quickly it recovers from a meal and is ready for another. That is why the absorption follows a different law in the two cases.

Capture of Electrons.

To predict the stellar absorption-coefficient we must accordingly fix attention on the rate of repair of the burst atoms. The atom is wandering about advertising a vacancy for an electron, and numbers of ejected electrons are rushing about on holiday. Many electrons will come up, look at the situation, and go off again. How is the atom to trap the electron into taking up the situation? I will give you the solution of this problem which I am inclined to think fairly probable, though I have not found many who agree with me. We may compare the electron to a stray planet entering the solar system from outside, bearing in mind, however, that the planets (satellite electrons) must be supposed to repel the invader, and the sun (positive nucleus) attracts it. Dynamics teaches us that, provided no actual material collision occurs, the intruder will scarcely ever be captured, but after stirring up things a little will retreat again towards infinity. There are exceptions, as when the sun and Jupiter conspire to capture a comet, but these would be very rare in the conditions corresponding to an atom. In some cases the intruder would turn the tables by carrying off a regular planet, thus compensating for the occasions when it was itself captured. Probably, as regards repair of the atom, as much harm as good would be done on the average.

More delicate persuasion being of no avail, there seems nothing left but for the atom to secure its electron by brute obstruction. For this reason I take the view that usually the capture of an electron occurs through its running against the positive nucleus of the atom. This nucleus has a highly complicated structure, the iron nucleus, for example, consisting of 86 distinct charges arranged in some kind of equilibrium. If by accident an electron runs full tilt into this packed mass, it will agitate it and lose energy in so doing; it will rebound, no doubt, but with smaller velocity insufficient to carry it out of the sphere of attraction of the atom.[3] By a process of exclusion this seems the only method consistent with dynamical laws by which the atom can secure the electron needed for its repair. Therefore I have concluded that the actual electron trap is none other than the positive nucleus—a region at the centre of the atom known to be about 10^{-12} cm. in radius. It must be remembered that the nucleus attracts the electrons and will sweep into the trap many which were not initially aimed at it.

This theory has been adversely critised mainly on the ground that it is entirely accordant with the laws of dynamics. At first sight that might not seem a grave objection; but we have got so used to the atom behaving in a way which violates the classical laws, that any theory which does *not* violate them is liable to be viewed with suspicion. While admitting that there are uncertain possibilities in the mysterious region in the interior of an atom, we must note that the present problem belongs to a class of investigations in which the usual dynamical laws are applied by physicists, often with much success. It concerns the motion of a free electron—not yet forming part of any permanent quantised system—a problem which occurs in the theory of conduction of electricity in metals, in thermionic phenomena, and in the scattering of α- and β-particles. In these problems physicists are accustomed to assume (rightly or wrongly) that the classical laws of dynamics are observed, and we have only followed their (good or bad) example. In particular in Rutherford's experiments on scattering, the classical laws of force are found to hold good almost to the boundary of the nucleus itself. There seems to be a fair presumptive evidence that our stellar problem should be attacked in the same way; although we admit that unknown circumstances may intervene.[4]

The strong point in our favour is that this theory

[3] The kinetic energy at the moment of collision with the nucleus is enormously greater than the kinetic energy before entering its sphere of attraction; so that a very small *proportionate* change of kinetic energy by collision would wipe out the original energy of the electron. The imperfect elasticity of the collision is a dynamical consequence of the complex structure of the nucleus. A collision of two simple charges may be perfectly elastic, except that that would apparently prevent a hydrogen nucleus from ever recovering its electron.

[4] While the fast-moving particles undoubtedly penetrate the atom in the way we have assumed, it is held by some that slow-moving electrons (as in the stars) are turned back at the surface. The idea seems to have originated at a time when the positive charge of the atom was thought to be a large sphere coextensive with it; and it seems out of keeping with modern views. It is ignored in current theories of conduction of electricity. Even if it were conceivable that a neutral atom could so ward off an electron, the strongly positive atoms in the stars could scarcely exclude it.

actually does give a value of the absorption-coefficient agreeing with astronomical observation. Thus for Capella the calculated value is 110 as compared with the observed value 150. There are certain doubtful factors which permit of the result being varied by a factor 2 or possibly 3; and we lay no stress on the precise accordance. But it appears to be possible to predict on this hypothesis the brightness of a star of known mass like Capella to within a magnitude, which amply solves the problem proposed to our physicist on the cloudy planet. It may be added that the theory also explains why the absorption in giant stars is nearly independent of the wave-length; but that is a more elementary result which becomes apparent as soon as we realise that the problem is concerned with the rate of repair of the atoms; many alternative theories of the conditions of repair would lead to the same conclusion.

Source of Stellar Energy.

The store of ætherial heat and the store of material heat in the star may be compared to the accumulators of a power station. We have not yet discovered the dynamos. The accumulators would run down in a few thousand years if they were not replenished. What is the source of the energy maintaining (and during the ascent of temperature increasing) this internal store? We believe now that the source is sub-atomic energy. One theory is that inside the star the simpler elements are gradually being built up into more complex elements, and energy is liberated in the process; a more drastic view is that matter is being entirely annihilated, setting free the whole of its energy of constitution. Taking the first theory, the most conspicuous known case is in the formation of helium from hydrogen. We do not know how to make helium from hydrogen, but we know that it is so made; we know also that 0·8 per cent. of the mass disappears in the process, and this must be the mass of the energy—æther-waves—liberated when the change occurs. Æther-waves weigh very light, and the energy available from this source is colossal. If 5 per cent. of the star consists of hydrogen which turns into helium as a first step in the formation of the higher elements, that would provide energy sufficient for all reasonable demands.

We might perhaps expect that the earliest stars would consist almost entirely of hydrogen, the evolution of the higher elements having little chance of beginning until the interior became hot enough to stimulate the process. But a difficulty arises here. For astronomical reasons it seems impossible to admit that even the earliest stars contain more than a very moderate proportion of hydrogen. I have referred to the fact that our calculations have been practically independent of the chemical constitution of the star; but one reservation ought to have been made—*provided it is not made of hydrogen.* Hydrogen gives results differing widely from all the other 91 elements.

To assume hydrogen as the material would in most cases destroy the general accordance of theory and observation; indeed it is a way of realising the goodness of this general accordance to note how it disappears when hydrogen is substituted instead of a normal element. I think, therefore, that the process of element-building from protons and electrons must have begun before the stellar stage is reached. This is a curious detached piece of knowledge to have come across in exploring the interior of a star—to be able to deny that it is mainly composed of hydrogen though any of the other 91 elements may be present to any extent; and it is still more curious that hydrogen should be the element which we were tempted to build the stars with, so that this apparently random denial hits the mark.

Admixture of hydrogen diminishes the proportion of ætherial energy and ætherial pressure, and so permits gravitation to aggregate larger masses. The occasional formation of stars of exceptionally large mass (20 to 80 times the sun's) may be due to the accidental prevalence of hydrogen in the region where they originated—that is to say, the material was in a more primitive state as regards evolution of the elements.

We need not be greatly concerned as to whether these rude attempts to explore the interior of a star have brought us to anything like the final truth. We have, I think, been able to recognise some of the leading factors participating in the problem and to learn how many varied interests are involved. The partial results already attained correspond well enough with what is observed to encourage us to think we have begun at the right end in disentangling the difficulties, and we do not anywhere come against difficulties which appear likely to be insuperable. The fact is that gaseous matter at very high temperature is the simplest kind of substance for a mathematical physicist to treat. To understand all that is going on in the material of a desk, for example, is a really difficult problem almost beyond the aspirations of present-day science; but it does not seem too sanguine to hope that in a not too distant future we shall be able to understand fully so simple a thing as a star.

Recent Scientific and Technical Books.

Volumes marked with an asterisk have been received at "NATURE" Office.

Mathematics

Birkemeier. Über den Bildungswert der Mathematik: ein Beitrag zur philosophischen Pädagogik. (Wissenschaft und Hypothese, Band XXV.) (Berlin: B. G. Teubner, 1923.) 4s. 6d.

Brewster, G. W. Commonsense of the Calculus. Cr. 8vo. Pp. 62. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 2s. net.*

Brownlee, J. Log Γ (x) from $x=1$ to 50·9 by Intervals of ·01. (Department of Applied Statistics (Computing Section), University of London, University College: Tracts for Computers, No. 9.) Demy 8vo. Pp. 23. (London: Cambridge University Press, 1923.) 3s. 9d. net.*

Dickson, L. E. History of the Theory of Numbers. Sup. Roy. 8vo. Vol. 3: Quadratic and Higher Forms; with a Chapter on the Class Number, by G. H. Cresse. (Publication No. 256.) Pp. v+313. (Washington: Carnegie Institution, 1923.) 3.25 dollars.*

Farnsworth, P. V. Industrial Mathematics Practically Applied: an Instruction and Reference Book for Students in Manual Training, Industrial and Technical Schools, for Home Study. Cr. 8vo. Pp. 282. (London: Scott, Greenwood and Son, 1923.) 8s. 6d. net.

Gauss, C. F. Carl Friedrich Gauss' Werke. Zehnten Bandes. Abt. 2. Abhandlungen I und V. Bachmann: Über Gauss' zahlentheoretischen Arbeiten. (Berlin: B. G. Teubner, 1923.) 5s. 6d.

Madelung, E. Die mathematischen Hilfsmittel des Physikers. (Band IV. der "Grundlehren der mathematischen Wissenschaften," herausgegeben von R. Tourant.) Pp. xii+247. (Berlin: J. Springer, 1923.) Grundzahl: 8.25 marks.

Nernst, W., und Schoenflies, A. Einführung in die mathematische Behandlung der Naturwissenschaften. Kurzgefasstes Lehrbuch der Differential- und Integralrechnung mit besonderer Berücksichtigung der Chemie. Zehnte, vermehrte und verbesserte Auflage. Roy. 8vo. Pp. xii+502. (München und Berlin: R. Oldenbourg, 1923.) 9s. 9d.*

Riemann, B. Über die Hypothesen, welche der Geometrie zu Grunde liegen. Neu herausgegeben und erläutert von H. Weyl. Dritte Auflage. 8vo. Pp. vi+48. (Berlin: J. Springer, 1923.) Grundzahl: 2.3 marks.

Sommerville, D. M. Y. Division of Space by Congruent Triangles and Tetraheda. (Proceedings of the Royal Society of Edinburgh, Session 1922–1923, Vol. 43, Part 1, No. 6.) Sup. Roy. 8vo. Pp. 85–116. (Edinburgh: R. Grant and Son; London: Williams and Norgate, 1923.) 2s. 8d.*

Steinmetz, C. P. Four Lectures on Relativity and Space. Med. 8vo. Pp. x+126. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 10s.*

Walker, C. A., and Ibbetson, W. S. Tables and Units for Engineering Students. 8vo. Pp. 40. (London: E. and F. N. Spon, Ltd., 1923.) 1s. net.

Mechanics: Mechanical Engineering

Bland, M. C. Handbook of Steel Erection. Fcap. 8vo. Pp. ix+241. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 12s. 6d.*

Casazza, G. I principî della meccanica alla luce della critica. Pott 8vo. Pp. 174. (Roma, Milano, Napoli: Albrighi, Segati e Cia., 1921.)*

Colvin, F. H., and Stanley, F. A. Machine Tools and their Operation. First edition, second impression. Med. 8vo. Part 1: Lathes, Drills and Drilling, Hand and Automatic Screw Machines Screw Machine Tools and Boring. Pp. vii+341. Part 2: Planers, Shapers, Slotters, Broaching, Milling, Gear Cutting and Grinding. Pp. vii+409. (London: McGraw-Hill Publishing Co., Ltd., 1922.) 20s. each part.*

Creager, W. P. La Construction des grands barrages en Amérique. Traduit de l'anglais par E. Callandreau et H.-P. Humbert. 8vo. Pp. 243+7 planches. (Paris: Gauthier-Villars et Cie, 1923.) 25 francs.

Croft, T., Edited by. Steam-Turbine Principles and Practice. (Power Plant Series.) Ex. Cr. 8vo. Pp. xi+347. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 15s.*

Dowd, A. A., and Curtis, F. W. Tool Engineering: Fixtures for Turning, Boring and Grinding. Med. 8vo. Pp. xi+340. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 17s. 6d.*

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Jauneaud, M. L'Évolution de l'aéronautique. (Bibliothèque de Philosophie scientifique.) Pott 8vo. Pp. 282. (Paris: E. Flammarion, 1923.) 7.50 francs.

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Ludin, A. Die Wasserkräfte, ihr Ausbau und ihre wirtschaftliche Ausnutzung: ein technisch-wirtschaftliches Lehr- und Handbuch. In zwei Bände. Manuldruck, 1923. 8vo. Pp. xxiv+1402+11 Tafeln. (Berlin: J. Springer, 1923.) Grundzahl: 65 marks.

Massey, G. B. The Engineering of Excavation. 8vo. Pp. 376. (London: Chapman and Hall, Ltd., 1923.) 30s. net.

Mease, J. A., and Nordenholt, G. F. Design of Machine Elements. Med. 8vo. Pp. vii+237. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 12s. 6d.*

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Weiss, J. B. Gliding and Soaring Flight: a Survey of Man's Endeavour to Fly by Natural Methods. Cr. 8vo. Pp. xx+164. (London: Sampson Low and Co., Ltd., 1923.) 5s. net.

Whyatt, H. G. Streets, Roads and Pavements: a Treatise on the Materials, Equipment, and Methods employed in the Construction and Maintenance of Roads and Footways; with Notes on Dust Prevention, Road Wear, Street Cleansing, Arterial Roads, and Road Planning, for Engineers, Students, and all those concerned with the Construction and Upkeep of Highways. (Pitman's Technical Primers.) Fcap. 8vo. Pp. 152. (London: Sir I. Pitman and Sons, Ltd., 1923.) 2s. 6d. net.

Winkel, H., Herausgegeben von Der praktische Maschinenbauer: ein Lehrbuch für Lehrlinge und Gehilfen, ein Nachschlagebuch für den Meister. Zweiter Band: Die wissenschaftliche Ausbildung. Teil 1: Mathematik und Naturwissenschaft. Bearbeitet von R. Kramm, K. Rüegg und H. Winkel. (Berlin: J. Springer, 1923.) Grundzahl: 7 marks.

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Allsop, F. C. Practical Electric Light Fitting: a Treatise on the Wiring and Fitting Up of Buildings deriving Current from Central Station Mains and the Laying Down of Private Installations. Ninth edition, revised and largely rewritten. Cr. 8vo. Pp. vii + 288. (London: Sir I. Pitman and Sons, Ltd., 1923.) 7s. 6d. net.

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Chemistry

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Barral, E. Précis d'analyse chimique qualitative. 2e édition. Pott 8vo. Pp. 735. (Paris: J.-B. Baillière et fils, 1923.) 26 francs.

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Blanchard, A. A., and **Phelan, J. W.** Synthetic Inorganic Chemistry: a Course of Laboratory and Classroom Study for First Year College Students. Third edition, entirely rewritten and greatly enlarged. Med. 8vo. Pp. xiv + 321. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 15s. net.*

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Hale, A. J. Modern Chemistry, Pure and Applied. Vols. I.-VI. Pp. vii + 280 each vol. (London: Virtue and Co., Ltd., 1923.) 95*s.* complete; 16*s.* per vol.

Hawk, P. B. Practical Physiological Chemistry. Eighth edition, revised. Med. 8vo. Pp. 709. (London: J. and A. Churchill, 1923.) 24*s.* net.

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New Methods of Crystal Analysis and their Bearing on Pure and Applied Science.[1]

By Sir William Bragg, K.B.E., F.R.S.

It is one of the most fascinating of all studies to trace back the properties of the substances that we see round about us to the manner and the details of their underlying structure. There are in the world, or indeed the universe, a certain number of different kinds of the atoms of which all things are made. We know of rather more than ninety in all. The science of radioactivity has brought to our notice atoms distinguished by special powers of emitting radiations, but the list is not really increased thereby. Everything we see round about us, or are aware of when perhaps we cannot see, is built up by joining together these atoms in various ways: and all the properties of substances, their infinite complications, powers, and beauties, are associated with the properties of the atoms even before construction is begun. It is surely no wonder that we try to find out how this is done.

Chemistry itself has its origin in this quest. One of its early successes was the explanation—incomplete, no doubt—of the part played by oxygen in the act of burning or rusting. As chemistry has grown to its present magnitude all its findings have related to the part played by this or that atom or combination of atoms in determining the properties of various substances. The methods of chemistry are founded on the study of the behaviour of crowds. The smallest portion of any substance handled in the laboratory contains billions of atoms; and the properties of the individual are inferred from the treatment of gross aggregates. The chemist mixes together two liquids in certain proportions, observes, tests, and weighs the results; and he infers that atoms already grouped in certain combinations are ready to change to fresh groupings. From his weighings he finds the proportions in which the atoms break with one another and recombine. He observes and measures their readiness to change partners. Sometimes the exchange is so rapid that energy is liberated with explosive violence. Sometimes it is so slow that it must be hurried, either by the application of warmth or by other means, the quaintest of which is the action of a catalyst, a third body which promotes a new grouping without being finally concerned in it; as the chaperone of bygone days effected the introduction between two people anxious to meet each other and then effaced herself.

The science of radioactivity takes up the study of the atom in a totally different way. It finds that sometimes atoms are endowed with movement so rapid that the individual has enough energy to make its own mark. In the spinthariscope of twenty-five years ago Sir William Crookes showed the separate and visible flashes which were made when a succession of helium atoms, shot out from radium, struck a phosphorescent screen. Each impact made its little flash of light just as when a pebble is dropped at night into a phosphorescent sea. This is a typical experiment belonging to the science of radioactivity, typical in that it deals with the individual and not with the crowd. In this science there is very little concern with the combinations of atoms. It leads more to a study of the nature of the internal structure of the atom: that is why if we wish to understand the atom's inner mechanism we turn to the work which J. J. Thomson, Rutherford, Aston, and others are doing. The new methods with which I deal here attack the question from yet another aspect, based on the recognition of the properties of crystals on one hand and of X-rays on the other.

A crystal that has grown without disturbance presents surfaces of brilliant polish which make with each other angles of characteristic and invariable magnitude. Sometimes one face grows abnormally as compared to others, on account, it may be, of some disposing cause in the circumstances in which the crystal was formed, but in crystals of the same substance the angles between corresponding faces are always exactly the same. There are not, usually, many different kinds of faces on a crystal. Often on careful examination it is found that there are not more than three or four. If we examine specimens of the same crystal which seem at first sight to differ in form, we find that the difference is nothing more than an unequal development of the various types of face. An outward presentment so simple as this must imply a like simplicity in internal design. There must be a unit of pattern which contains but few atoms and, repeated again and again through space, makes up the whole crystal. The idea has long been familiar to the crystallographer, but he could not push the corresponding interpretation to its limits: he had no clue to guide him, no methods of examining the actual details of the design. The reason of the failure is not difficult to understand: the details were too fine to be distinguished under the most powerful microscope. Nor is this a mere question of a lack of technical skill which might be removed at some future time. It will never be possible to see the arrangements of atoms in a crystal.

When we say that we see any particular thing, what we really do is to observe some change which the thing has made in the light waves which reach our eyes after they have been reflected or scattered or in

[1] Sixth Trueman Wood Lecture, delivered at the Royal Society of Arts on January 24.

some other way affected by the thing that is seen. This means that the thing itself must be comparable in size with the wave-length of light. We could not expect to gather from the behaviour of a breaker as it rushed up the beach information as to the size and form of the individual grains of sand over which it had passed. We might expect, however, to be able to gather information as to the extent of a reef from observation of the degree to which it had stilled the waves that traversed it before they reached the shore. Now, the diameter of an atom is quite a thousand times less than the length of the light-waves which affect our eyes. Consequently it is out of the question that we should ever see it in the sense that we can see small objects even under the microscope. A very simple way to realise this point is to consider that the atoms form part of the very lenses of the microscope; and, if we tried to increase our power of microscopic vision by redesigning the optical arrangement, the lenses would have become, so to speak, granular and have lost their optical properties long before we were able to "see atoms by their aid." The fact is that light-waves are adapted for ordinary seeing, and that by the microscope we have stretched their proper range some thousands of times. Nothing that we can ever do with ordinary light will give us the magnification of a hundred million times, which is what we require if we are to study the atoms themselves. We want a new sort of light of immensely finer quality than ordinary light; and we have been fortunate enough to find this in the X-rays. X-rays are simply a form of light the wave-length of which is ten thousand times shorter than that of the light with which we see in the normal way.

There is one more point to be made clear before we can realise how the combination of X-rays and the crystal has opened up a new vista. Although the X-ray is so fine in structure that it can really be affected by the individual atom, the magnitude of that effect is too small to be of any use: it is here that the crystal helps us. We remember that there is in the crystal a perfectly regular repetition of some simple pattern or combination of atoms. When X-rays sweep over them, whatever effect one of the units has, all its fellows have also; and so on the whole there is a combined action big enough in its results to be detected by instruments designed for the purpose. In somewhat the same way, to take an example, each tiny furrow on a piece of mother-of-pearl is of the right order of width to have an effect on the light which is reflected by the whole piece, but the magnitude of one such effect is not enough to make an impression on our eyes. However, on the surface of the pearl there are many thousands of such furrows very like one another and running more or less in the same direction, and what one furrow does the others do also. It is this combined or multiplied action which so affects the light as to give the beautiful play of colour associated with mother-of-pearl.

Now we have all the factors essential to the new methods: the X-rays for fineness of vision and the crystal for combination in the action of the atoms upon the X-rays. It is not necessary now to go into further details; it is only needful to realise that there is an instrument called the X-ray spectrometer in which the reaction between the X-rays and the atomic arrangements enables us to study the form and size and disposition or structure of the atomic patterns of the crystal.

Every crystal is in a way a long avenue down which we can look and see at the far end of it the most primitive groupings of the atoms. The wonder is that we should be able to look so far, that the structure of the crystal should be so finished and so unvarying from first to last that our observation of a crystal big enough to handle should tell us no more and no less than the properties of the one little unit of pattern. If the diamond in a ring were increased to the size of the earth the individual carbon atoms would only be about as big as tennis balls. Yet so faithful is the information which X-rays and crystals give us that we can compare, and indeed measure, the distances from atom to atom with an error less than 1 part in 1000. This new power, which is surely wonderful enough, we naturally apply to the further elucidation of the problem which I described at the beginning. We try to find out, by fresh means, the relations between the properties of substances and the nature of the atomic structures of which they consist.

It might be objected that a crystal is something special and that most bodies do not show the perfect crystalline form. The difficulty is apparent, not real. In the first place, far more substances are crystalline than would be supposed, and actually every substance would more naturally develop into a perfect and characteristic crystal than into any other form. The crystal is the natural condition. Bodies which seem to us to present no crystalline appearance at all are often aggregates of minute crystals jammed together miscellaneously or held like a mush in a semi-liquid matrix. Often, again, as in the case of liquids, the various atoms and molecules have not had time nor peace enough to arrange themselves as they would. Even if many of the substances in the behaviour of which we are most interested, such as iron and steel, are far in form from the perfect crystal, yet we may expect to arrive in the end at an understanding of their structure by the separate examination of the few definite forms of crystal of which, as we know well, the whole mixed mass is compounded.

We may now go on to consider individual cases. It is, perhaps, natural to a new form of inquiry to deal with particular instances of its application as they have been so far made, rather than to attempt broad generalisations. As we consider each case let us look at it from the point of view already emphasised. Let us try to see how the properties of the whole crystal depend strictly upon and are, indeed, an index to the properties of the atoms and atomic combinations of which it is made.

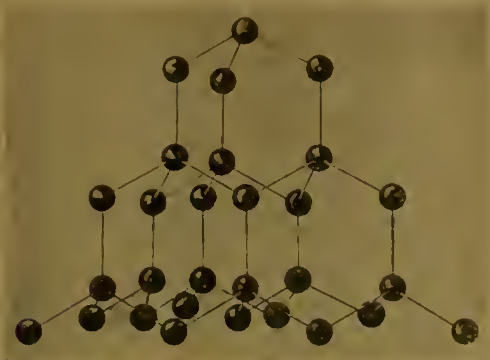

FIG. 1.—Diamond; showing how each carbon atom, represented—only diagrammatically—by a black ball, lies at the centre of gravity of its four nearest neighbours.

The diamond is, perhaps, the best to begin with. Its unique qualities dispose us to expect a structure which is equally distinguished, and so it turns out to be. The structure is figured in the accompanying sketch (Fig. 1). It may look at first sight somewhat complicated, but when it is examined closely it is found that the whole story is told in one sentence. Each atom has four neighbours regularly disposed about it. In other words, the four make a regular tetrahedron, and the first atom is at the centre of it. In the arrangement so determined by X-ray analysis we recognise at once an agreement with one of the most important deductions of the chemist, the so-called tetravalency of the carbon atom, which means a tendency to associate itself with its neighbours by four bonds of equal strength. The hardness and strength of the diamond are based on the simplicity and regularity of this tetrahedron arrangement, and in addition on the strength of the tie between atom and atom. We find that atoms are fastened together by bonds of two or three different types; the one here illustrated is the strongest of all. Every atom, we know nowadays, consists of a central core, which is positively electrified, and of a sufficient number of negative bodies of a second kind called electrons to balance the positive charge on the core. The diamond is an example of many cases where neighbouring atoms share electrons and build them each into their own structure. It is somewhat analogous to the sharing of party-walls by the houses of a terrace. Yet it can be seen that the structure is obviously weaker in certain directions than in others. Such are the horizontal planes in the figure. These are called the cleavage planes. The diamond-worker takes advantage of the fact, using it skilfully instead of grinding. An excellent example is to be found in the exhibit of the Crown Jewels in the Tower, where the manner of cleaving one of the great diamonds is shown. There is a second plane of cleavage, which is only used by workmen of the greatest skill, as it is much more difficult to bring off the operation successfully. It is at right angles to the plane of the first kind. The tetrahedral form of structure is often reproduced in the form of the whole diamond, though no one, I believe, knows exactly why the faces of the tetrahedron are often rounded. This does not mean that the layers of the atoms are curved, but simply that they lie on one another like a series of steps. A structure so tightly bound together is brilliantly clear from the optical point of view.

There is another form of carbon crystal, that of graphite or black lead, the properties of which seem so different from those of the diamond that it is difficult to believe they are of the same element and, moreover, of much the same construction. One common feature is of great interest, namely, the existence in both cases of layers of atoms arranged in hexagonal pattern. It is difficult to express in words, but the illustration (Fig. 2) will make it clear. Each atom is still bound to three

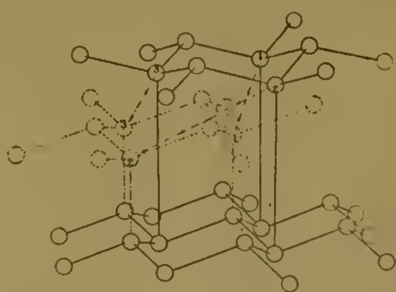

FIG. 2.—The fine lines of the diagram show the structure of graphite. By moving the top layer to the position shown by the broken lines the diamond structure is obtained.

of its neighbours by the same strong ties as before, but the fourth is broken and a weaker, lengthier connexion is substituted. All this is reproduced in the outward appearance of graphite. Its crystals are badly formed, but are more or less in hexagonal columns, which split up with the greatest ease into thin leaves at right angles to the column axis. So easy, indeed, is this cleavage that the pounding of a mass of graphite in a mortar is ludicrously ineffective. The leaves simply multiply themselves more and more. One leaf slides on another very easily, yet the atoms in each leaf hold well together. It is the combination of these qualities that gives to graphite its lubricating powers. If you slip on the black-leaded hearthstone, it is because some of the layers which are sticking to the sole of your shoe slide on others which cling to the stone. I do not know that you can find a better example of the relation between the external features of a crystal and its elementary structure. One change has converted the hard diamond into the soft, slipping graphite, and it is easy to see that the results are exactly what one would expect from the nature of the change.

Now we may pass on to another structure which is much like that of the diamond, namely, that of ice (Fig. 3). The fundamental element of the design is again the fact that an atom, oxygen in this case, is surrounded symmetrically by four other atoms of like kind; the latter making a regular tetrahedron of which the former is the centre. But there is this difference between diamond and ice: that in the latter case an atom of a second type, namely, hydrogen, is inserted between every pair of oxygen atoms. Thus, the immediate neighbours of each oxygen are four hydrogens. As every hydrogen has only two oxygen atoms as neighbours, there are twice as many hydrogens as oxygens in the structure. That is, of course, in agreement with the known composition of water.

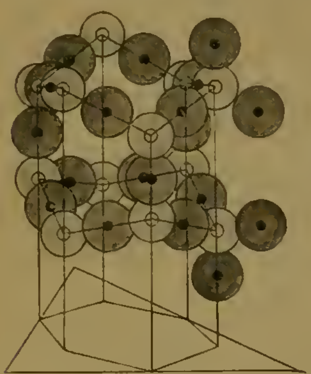

FIG. 3.—Ice. White spheres represent oxygen atoms, and the black spheres hydrogen: enough of each kind are drawn to show the hexagonal nature of the crystal. Each black ball lies between two white: each white touches four blacks, but in two cases only, on the right of the diagram, the full number, four, is put in. The distance between the centres of two neighbouring oxygens is known with accuracy, but it is not known how much of the intervening space is occupied by the hydrogen.

Here, also, as in diamond and graphite, are to be found layers in which the atoms are arranged in a hexagonal pattern. Arctic explorers have described a hexagonal structure in the ice-floes; the block breaking up into hexagonal vertical columns resembling the pillars of the Giant's Causeway. But the most beautiful ice-crystals are found in the snowflakes or in the frost figures on the window. The forms are of an intricate delicacy based always on the hexagon and on the angle of 60°. In the model which is illustrated the foreshadowing of the sixfold symmetry is shown. The featheriness of the snow is the outward expression of the lightness of the pattern, which resembles lace rather than a continuous structure. It is clear that the atoms could be packed more tightly, and that must have something to do with the fact that when ice is compressed it tends to melt. It is not easy to understand why the atoms join together in this of all possible ways. It is evident that particular points in the structure of one atom are linked up with corresponding points in the structure of another. Such considerations have, no doubt, to do with the internal structure of the atoms themselves,

It is a curious fact that when a tetrahedral structure is found, as in the cases of diamond and ice, there is an alternative with respect to one of the details. By a slight structural change somewhat difficult to describe in words, the tetrahedral arrangement of the diamond becomes the usual hexagonal arrangement of ice. Mr. Whipple has directed my attention to a paper written about a hundred years ago, in which the author describes ice-crystals of peculiar form which he had found on the wooden bridge of Queen's College, Cambridge. It is possible to make out from the description that in this case the ice had grown as a diamond would do: the effect is described as one of great beauty and brilliance.

There is one feature of the carbon structures which is of great interest. The hexagonal ring of six atoms is to be found both in diamond and graphite. Now, a whole branch of chemistry of first-rate importance is concerned with the examination of substances of which such a ring forms the essential element of design. When an atom of hydrogen is attached to each atom of carbon the ring with its fringe is the molecule of benzene. The ring is an extraordinarily persistent combination.

Organic chemists have learnt that they can detach at will one or more of the hydrogens, replacing them by somewhat more complicated groups, such as the pair of oxygen and hydrogen atoms called the "hydroxyl group," or the "nitro group," consisting of one nitrogen and two oxygens, and so on. In this way an immense number of different substances are formed of widely varying properties. They occur in the work of the dye chemists, in the manufacture of explosives, in the study of living organisms, and, in fact, constitute a most important class of bodies. Chemists have inferred the existence of these rings by reasoning processes of really wonderful accuracy and power. It is natural to suppose that the ring which we find in our structures is the very ring which has been the concern of the organic chemist.

We have tried to put this idea to the test, and so far, I think, with success. We can measure this ring in the diamond. It is just one hundred millionth of an inch across, and we can make good estimates of the enlargements that must result from such substitutions for the hydrogens as I have already described. We can then measure the space which the rings, modified or not, occupy in the organic crystal, and we get a very satisfactory fit (Fig. 4).

We have, for example, estimated the size and form of the molecules of naphthalene and anthracene on the assumption that they consist, respectively, of two benzene rings, and three benzene rings, in line; in accordance with chemical evidence. We have found, by X-ray analysis, the size and form of the unit cells (Fig. 6); a simple calculation shows that two molecules have to be packed into the cell in each case; the crystals, it should be observed, are isomorphous.

Fig. 4.—Showing mutual relations of three naphthalene molecules and parts of others. Letters are attached to all the carbon atoms of one molecule; hydrogen atoms completing this molecule are attached at A B C D G H I J.

It is found that the molecules pack into place very well, if they are arranged as in the sketch of Fig. 4. The figure refers to naphthalene, but the modification required for anthracene is readily conceived; and, indeed, it appears that the cell in one case is exactly as much longer than in the other as would be expected considering that the anthracene molecule contains one more ring than the naphthalene. Here again we may see in the structure of this little unit of naphthalene, which contains two double rings, everything that foreshadows the properties of the whole crystal. Why is the substance so light? Because the structure is so lace-like and there are so many empty spaces. Why does it break up so easily into thin flakes? Because the molecules lie side by side somewhat like corn bent by the wind, and their side-to-side attachments differ from those that are end to end: the latter break more easily and the substance naturally splits up into layers, each of which is like a velvet pile, the fibres of which represent the molecules. Why does the substance melt so easily? Because *all* the attachments of molecule to molecule are feeble and break up under disturbances due to heat. And so we may go on. If we attach a hydroxyl group to the side of the molecule we see the fibres of the pile open out sideways. If we attach it at the ends, we find the fibres grow longer; the two substances formed in this way are well known in the dye industry.

We have recently been examining the crystalline form of a number of the organic substances, and have learnt something of a very interesting system which governs the packing. It holds for all crystals apparently, but is very plain in the organic field. There are two stages in the process of the formation of the crystal from the original atoms. First of all, the atoms are grouped into companies which the chemist calls "molecules." Chemistry has concerned itself largely with the study of the molecule, and particularly with the molecule in the free state, as in a liquid or a gas. In the second stage the molecules, retaining their composition if not their exact form, are packed together to make the crystal pattern: it is this stage which is the subject of our present considerations, and can be analysed by the X-ray methods. Take a simple example:—Two atoms of hydrogen and one of oxygen make up the water molecule. It is a company of atoms strongly tied together in an alliance which stands much rough treatment. The molecules can exist in a state of independence as steam or water vapour: in a condition of semi-independence they associate themselves together as water. We know how much care has been given to the study of the water molecule in both these states. Now, in the second stage the molecules are arranged side by side and end to end to form the crystal of ice. It has been necessary to take away much of their motion in order to induce them to take the new form. They are no longer running hither and thither, twisting and spinning with the energy of their motion. They lie more quietly now, still quivering, no doubt, but tied together so that they can no longer change appreciably their relative positions. They are now the crystal to be investigated by the new methods: the result is shown in Fig. 3, already described.

We find that when the molecules are packed into the crystal pattern—and they do not seem to suffer much in the process—they are put together just as anyone would try to pack a box with objects all alike in shape but individually of irregular or, one might say, of awkward form. How would you pack a box full of boots? You would naturally put them in pairs, the right boot over the left in the familiar way. It is just such methods of packing that are followed in a crystal. It is convenient to illustrate by means of models. Here are a number of wooden "shoes" which are to represent molecules without symmetry in their form. Take four of them and put them together in the manner illustrated (Fig. 5). The result is a pattern which possesses a certain amount of symmetry,

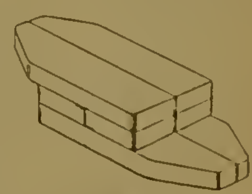

Fig. 5.—Arrangement of the four "shoes" showing the mutual orientation but not the mutual positions of the four molecules usually found in a monoclinic prismatic crystal such as benzoic acid or phthalic acid.

the same, in fact, as that of the boxes in Fig. 6. This is a very convenient form for packing, and it appears that a majority of known crystals pack together in this way. All of them show the symmetry that might

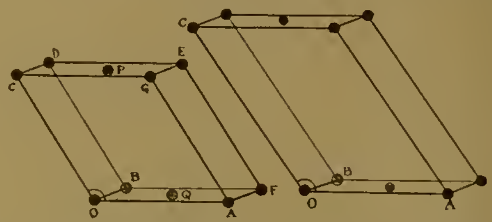

FIG. 6.—Unit cells of naphthalene and anthracene drawn to the same scale (10^8 to 1). It is apparently usual for cells of this kind to contain four molecules, but in these two cases they contain two only; that is because the molecules have some symmetry of their own. The molecules shown in Fig. 4 fit into the naphthalene cell. If the unshaded molecules be supposed to be placed with one end at Q, its general lie is parallel to OC. The two shaded molecules of Fig. 4 would then be placed with their ends at B and F. The anthracene molecule is like that of naphthalene except that there are three rings in a line instead of two: the axis OC is correspondingly larger.

be expected. They are exactly alike on either side of a dividing plane: in other words, they are exactly like their reflection in a mirror. They have, too, an "axis of symmetry"; a half turn about the axis brings no apparent change. Fig. 7 is an illustration

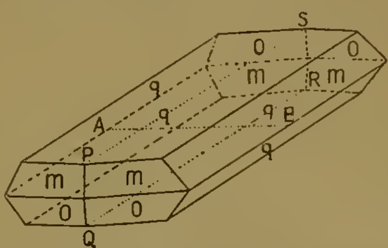

FIG. 7.—Phthalic acid, a monoclinic prismatic crystal possessing a plane of symmetry PQRS, and an axis of digonal symmetry AB, but there is no plane of symmetry through AB. Faces marked by the same letter are alike. The mutual orientation of the four molecules in its unit cell is that of the shoes in Fig. 5.

of a crystal of this kind. The X-ray methods show us that there are four molecules in the unit of pattern, and that they are arranged in the manner described

It is very interesting to observe the result of a different arrangement. Sometimes a set of four are arranged as in Fig. 8, like two pairs of shoes back

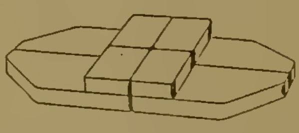

FIG. 8.—The relative orientations but not the relative positions of the four molecules in the crystal unit cell in resorcinol.

to back. The top and bottom are now unlike, but there is a greater symmetry in other directions. We have recently examined a crystal substance, resorcinol, which is built on this pattern; its external form is shown in Fig. 9. The fundamental molecule is a benzene ring in which two hydrogens have been replaced by two hydroxyl (oxygen-hydrogen) groups. The crystal shows clearly different forms at its two ends, the difference of which is shown in another very interesting way. If the crystal is warmed, one end of it becomes positively electrified and the other negatively. We have been able to go some way to the actual determination of the relative positions of the molecules: the results are shown in Fig. 10. There are two sets of planes perpendicular to the axis, which in the crystal occur alternately. In each plane there are two types of molecule, counting difference of orientation as difference of type. The plain lines in the diagram show the arrangement of the two types lying in the plane of the paper, and are marked A and D. One of them can be obtained from the other by a revolution through 180° in the plane. They are joined by long and by short lines, the former containing the oxygens of the hydroxyl groups. The arrangement of the next plane, above or below the first, is shown by the dotted lines: the molecules in this plane can be obtained from those in the first by reflections, with proper translations, across planes that are perpendicular to the paper and cut it in lines parallel to either of the sides of the rectangle. The arrangement is clearly governed by the necessity of fitting the molecules together so as to accommodate the hydroxyl attachment.

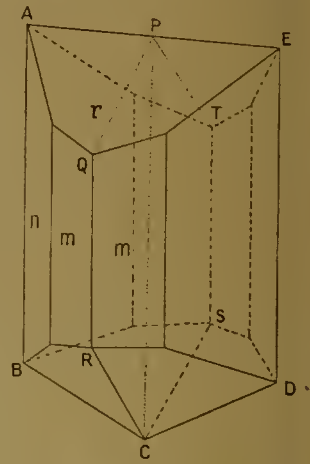

FIG. 9.—Resorcinol, a rhombic pyramidal crystal, having two planes of symmetry, AEDCB and PQRCST, and an axis of digonal symmetry PC.

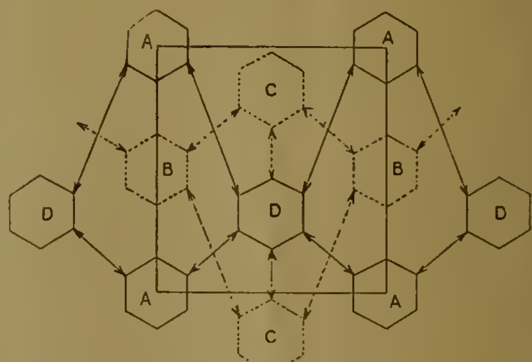

FIG. 10.—Probable arrangement of molecules in resorcinol.

Another case of great interest and importance is the two-molecule cell, the two being exactly alike. How would you pack a box with boots all right-footed or all left-footed? You cannot find a way of packing which will make the result symmetrical on either side of a plane. Neither do you find a crystal, built on such a basis, to have right and left symmetry. The crystal of tartaric acid, investigation of the properties of which established the fame of Pasteur, is an excellent

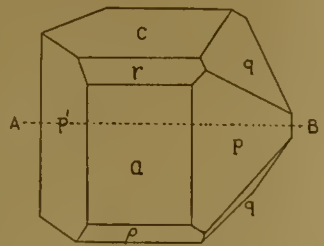

Fig. 11.—Tartaric acid, a monoclinic sphenoidal crystal, having an axis of digonal symmetry, AB, and no other axis or plane of symmetry.

example. Its peculiar form is shown in Fig. 11. A recent publication by Mr. Astbury gives the proof that there are two molecules in the unit cell. Their mode of arrangement in terms of "shoes," which are of one kind only, is shown in Fig. 12. The arrange-

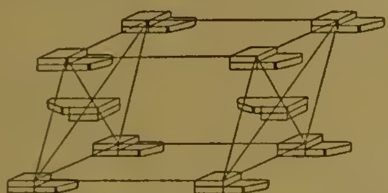

Fig. 12.—Arrangement of "shoes" of one kind only representing the arrangement of molecules in tartaric acid.

ment of the atoms in one molecule, represented in Fig. 12 by one shoe, is shown in Fig. 13. A model of the crystal is shown in Fig. 14; and diagrammatic representations of the atoms in two adjacent molecules are given in Fig. 15 (*a*) and (*b*): one of these figures is right-handed and the other left. The most striking

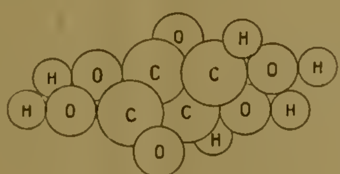

Fig. 13.—Molecule of tartaric acid.

physical property of the crystal is its power of rotating the plane of polarisation of light which traverses it. It has long been guessed that there must be some spiral arrangement in the structure: and this is beautifully confirmed in the model. There are, in fact, two spirals. This is somewhat unexpected, but it explains in a delightful way a property which has been obscure. One of the spirals is in the interior of the molecule itself and is certainly permanent when the crystal is dissolved. That accounts for the fact that tartaric acid in solution is "active," that is to say, can exercise its rotatory power. But the second spiral is a twist brought in by the necessity of fitting

Fig. 14.—Tartaric acid. The small balls represent hydrogen atoms, the larger black balls oxygen, and the largest two grey and two black balls carbon. Scale of the model is 10^8 to 1.

the molecules in their places. It is a peculiarity of the crystal structure, not of the molecule: it is a right-handed screw if the first is a left-handed screw, and *vice versa*. Also it appears to be more powerful in its effect on the light; so that when the tartaric acid

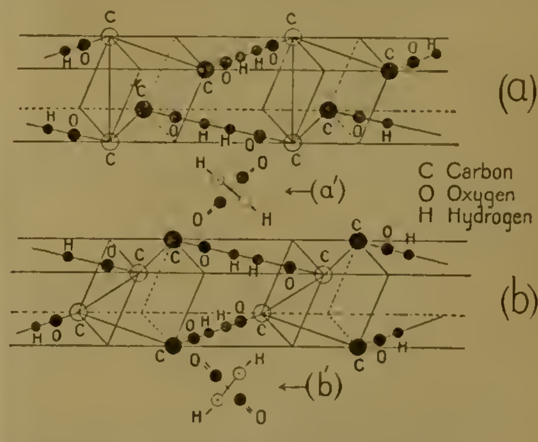

Fig. 15.—Tartaric acid; (a) and (b) represent two molecules end to end; (a') and (b') show corresponding cross-sections with the side attachment. The two sets of figures are right and left to each other.

as a crystal rotates light in one sense, in solution it rotates light in the opposite sense. Here, again, the intricate effects of the whole crystal are directly referred to structural details.

It is to be observed that in this case there could be no question of the existence in the crystal of two molecules related to one another as right to left. For the mirror reflection of a right-handed screw is a left-handed screw, and the whole effect depends on a want of balance. In this case also there is a plane of cleavage, passing through the points where the molecules join each other end to end.

Quartz is another example of a crystal possessing rotatory power, and like tartaric acid it contains a special element in its construction. The X-ray

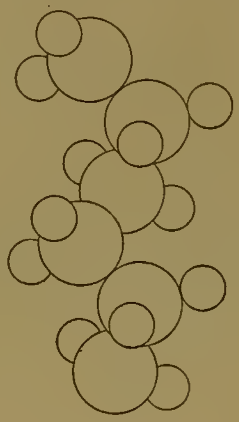

Fig. 16.—Spiral construction in quartz: large balls silicon, small balls oxygen.

methods make this very clear, and give us also some indications as to the structural system. In the model shown in Fig. 16 the large balls represent the atoms of silicon and the smaller those of oxygen. The spiral character of the fundamental crystal is beautifully manifested in its outward form. The illustration (Fig. 17) shows the two possible forms of the crystal,

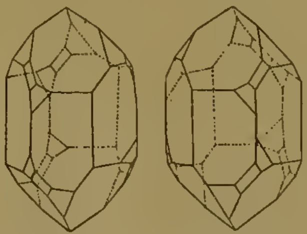

Fig. 17.—Right- and left-handed quartz.

right-handed and left; a certain set of small faces gives to each crystal a spiral appearance.

These various examples have been given as illustrations of the tasks which the new method of crystal analysis undertakes. They belong to a new field of research, akin to chemistry in that they seek to refer the properties of substances to the nature of the elements of construction. Chemistry has, however, concerned itself in the main with the relatively free molecules of liquids and gases: here we deal with the properties of the solid. Our concern is to explain the strength and elasticities of materials, their power of conducting electricity and heat, their electrical properties, optical properties: all these characteristics and many more, in terms of the structure as revealed by the X-ray analysis. Here are, we may say, the contributions of the method to pure science.

It is natural to say something of the possible application to applied science. The properties of solid materials are of such fundamental interest to all arts and crafts that any new insight into their origin is necessarily important. But, at the same time, applications of science to industry are always unexpected in nature and time. What we have now to do from the purely scientific side lies plain before us: how and when any result will have practical value cannot be foreseen.

Much attention has been given to the immensely interesting problems of the crystallisation of iron and steel. Westgren in Sweden, Bain in America, and others, have done good work on the structure of the various forms of iron, α, β, γ, and δ.

In Great Britain, the effect of the crystalline form on the strength of a material has been examined by G. I. Taylor and Miss Elam in the case of the beautiful aluminium crystals of Prof. Carpenter. The crystals are very easy to deform because certain planes of easy slip traverse the whole crystal, and these planes are always the first to give way. The X-rays show the structure of the crystals and the position of the planes. When the large crystals are broken up into smaller, oriented in all ways, the material becomes stronger because in whatever way a stress is brought to bear some of the crystals are ready to bear it.

Kaolinite, which can be examined, though in the form of a very fine powder, shows clearly a crystalline structure: by the same methods it can be shown that the structure disappears when the temperature is raised to a certain point. These facts were, at least in part, anticipated by the scientific branches of the pottery industry: but this method provides a useful confirmation, and further investigation promises to be very interesting. Calcined at 900° C., a new crystalline structure appears: and when the temperature has been sufficiently raised, the X-rays show that sillimannite has formed.

Such examples are mere pointers in a direction in which we may hope there will be a great movement in time to come. Our first aim is to develop the new methods as pure science. A broad, straight road opens out before us, and the going is good. As we travel along it we shall, doubtless, find many side turnings leading to useful applications, but we must not expect them until we are right opposite to them. Our first and obvious duty is to travel down the high-road as far as it will take us.

Recent Scientific and Technical Books.

Volumes marked with an asterisk have been received at "NATURE" *Office.*

Mathematics

Bally, É. Principes et premiers développements de géométrie générale synthétique moderne. Roy. 8vo. Pp. viii + 218. (Paris: Gauthier-Villars et Cie, 1922.) 20 francs.*

Barker, W. H. The "Akribos" Pocket Card of Four Figure Logarithmic and other Tables. 5⅝ in. × 3⅞ in. (London: Philip and Tacey, Ltd., 1923.) 2*d.* net.*

Bryant, V. S. Introduction to Practical Mathematics. Cr. 8vo. Pp. 95. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 2*s* 6*d.* net.*

Dickson, L. E., Mitchell, H. H., Vandiver, H. S., and **Wahlin, G. E.** Algebraic Numbers: Report of the Committee on Algebraic Numbers. (Bulletin of the National Research Council, Vol. 5, Part 3, No. 28.) Sup. Roy. 8vo. Pp. 96. (Washington: National Academy of Sciences, 1923.) 1.50 dollars.*

Dingler, H. Das Problem des absoluten Raumes: in historisch-kritischer Behandlung. Pp. 50. (Leipzig: S. Hirzel, 1923.) Grundzahl: 1.50 marks.

Eisenhart, L. P. Transformations of Surfaces. Med. 8vo. Pp. ix + 379. (Princeton: Princeton University Press; London: Oxford University Press, 1923.) 20*s.* net.*

Fawdry, R. C., and **Durell, C. V.** Calculus for Schools. Cr. 8vo. Pp. viii + 300 + xx. (London: E. Arnold and Co., 1923.) 6*s.* 6*d.**

Haslam, C. H. Modern Arithmetic. Cr. 8vo. Pp. 68. (London: Relfe Bros., Ltd., 1923.) 3*s.* 6*d.* net.

Haslam, C. H. The Modern Practical Arithmetic. Gl. 8vo. Part 1. Pp. 24. (London: Relfe Bros., Ltd., 1923.) 5*d.* net.

Kirby, R. S. Exercises in the Elements of Descriptive Geometry. Oblong Sup. Roy. 8vo. Pp. x + 49. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 5*s.* net.*

Poradnik dla Samouków. Tom 3: Matematyka. Uzupelnienia do tomu Pierwszego. 4to. Pp. viii + 102. (Warszawa: Im. Mianowskiego, 1923.) 10,000 marks.*

Ricci, G., et Levi-Civita, T. Méthodes de calcul différentiel absolu et leurs applications. (Collection de Monographies scientifiques étrangères.) Réimpression. Roy. 8vo. Pp. 125-201. (Paris: A. Blanchard, 1923.) 9 francs.*

Roy, M. Sur la théorie des surfaces portantes. (Collection "Scientia," No. 39.) Cr. 8vo. Pp. 130. (Paris: Gauthier-Villars et Cie, 1923.) 12 francs.*

Saunders, V. T. Practical Mathematics. Fcap. 4to. Pp. 46. (London: G. Bell and Sons, Ltd., 1923.) 1*s.* 6*d.**

Mechanics: Mechanical Engineering

Aeronautical Research Committee: Reports and Memoranda. No. 753: Investigations of the Wind Forces and Movements acting on Models, $\frac{1}{16}$ scale, of the Caquot Kite Balloon. 1*s.* 3*d.* net. No. 795: Prevention of Fire in Single-engined Aeroplanes. 1*s.* net. No. 796: Possible Causes of Fire in an Aeroplane Crash. 1*s.* 6*d.* net. No. 805: Some Calculations dealing with the disturbed Motion of an Aeroplane. 6*d.* net. No. 808: Pressure Plotting on Fin and Rudder of a Model of R32. 2*s.* net. No. 812: Experiments on Rigid Airship R32. Part 2: Controllability and Turning Trials. 1*s.* net. No. 815: Measurement of Normal Force and Pitching Movement on Rigid Airship R33. 1*s.* 3*d.* net. No. 816: Comparison between the Aero-dynamic Properties of Two Aerofoils of the same Section, but with Square and Rounded Wing Tips respectively. 6*d.* net. No. 817: Wind Tunnel Tests on a Fokkar Biplane. 3*d.* net. (London: H.M. Stationery Office, 1923.)

Besnerais, M. le. Théorie du navire. (Collection Armand Colin.) Fcap. 8vo. Tome I. Pp. 162. (Paris: A. Colin, 1923.) 5 francs.

Coleman, G. S. Hydraulics applied to Sewer Design. Demy 8vo. Pp. viii + 150. (London: C. Lockwood and Son, 1923.) 10*s.* 6*d.* net.*

Cooper, the late G. S. By-product Coking. Second edition, enlarged and completely revised by E. M. Myers. Demy 8vo. Pp. xv + 192. (London: Benn Bros., Ltd., 1923.) 12*s.* 6*d.* net.*

Cormac, P. A Treatise on Engine Balance using Exponentials. Demy 8vo. Pp. xi + 151. (London: Chapman and Hall, Ltd., 1923.) 21*s.* net.*

Cunningham, B. The Dock and Harbour Engineer's Reference Book: Notes on Various Matters connected with Maritime Engineering and Ports and Harbours. Second edition, revised. Fcap. 8vo. Pp. 325. (London: C. Griffin and Co., Ltd., 1923.) 9*s.* net.

Department of Scientific and Industrial Research: Food Investigation Board. Special Report No. 15 by the Engineering Committee of the Board. Insulated and Refrigerator Barges for the Carriage of Perishable Foods. Roy. 8vo. Pp. iii + 21. (London: H.M. Stationery Office, 1923.) 1*s.* net.*

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Emperger, F., Herausgegeben von. Handbuch für Eisenbetonbau. Dritte, neu bearbeitete Auflage in 14 Bänden. Band 5: Flüssigkeitsbehälter, Röhren, Kanäle. (Berlin: W. Ernst und Sohn, 1923.) Grundzahl: 16.20 marks.

Fremont, Ch. Le marteau, le choc, le marteau pneumatique. (Études expérimentales de technologie industrielle, 64e Mémoire.) Demy 4to. Pp. 194. (Paris: chez l'auteur, 25 rue du Simplon, 1923.)

Izart, J. Aide-mémoire de l'ingénieur mécanicien: Recueil pratique de formules, tables et renseignements usuels. 4e édition. Ex. Cr. 8vo. Pp. xxvi + 1125. (Paris: Libr. Dunod, 1923.)

Kempe, H. R., and **Smith, W. H.,** Edited by. The Engineer's Year Book of Formulae, Rules, Tables, Data and Memoranda for 1923: a Compendium of the Modern Practice of Civil, Mechanical, Electrical, Marine, Gas, Aero, Mine, and Metallurgical Engineering. (Thirtieth year of publication.) Gl. 8vo. Pp. 2882. (London: C. Lockwood and Son, 1923.) 30*s.* net.

Larrouy, M. Le Ballon et l'avion; la route aérienne. (Collection Armand Colin.) Fcap. 8vo. Pp. 216. (Paris: A. Colin, 1923.) 5 francs.

Laubeuf, M., et Stroh, H. Sous-marins, torpilles et mines. (Grandes Encyclopédies industrielles.) Med. 8vo. Pp. 810 + 10 planches. (Paris: J.-B. Baillière et fils, 1923.) 60 francs.

Lea, F. C. Hydraulics: for Engineers and Engineering Students. Fourth edition. Demy 8vo. Pp. 606. (London: E. Arnold and Co., 1923.) 18*s.* net.

Popplewell, W. C., and **Carrington, H.** The Properties of Engineering Materials. Demy 8vo. Pp. xii + 540 + 34 plates. (London: Methuen and Co., Ltd., 1923.) 28*s.* net.*

Ricardo, H. R. The Internal-Combustion Engine. Sup. Roy. 8vo. Vol. 2: High-Speed Engines. Pp. vii + 373. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1923.) 30*s.* net.*

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Smith, C. A. Middleton, and **Warren, A. G.** A Handbook of Testing. Demy 8vo. Volume 2: The Theory of Prime Movers. Pp. xi + 299. (London: Constable and Co., Ltd., 1923.) 22*s.* 6*d.* net.

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Haler, P. J., and Stuart, A. H. An Introduction to Physics for Technical Students. Cr. 8vo. Pp. 240. (London: G. Bell and Sons, Ltd., 1923.) 3*s.* net.

Harris, P. W. Practical Wireless Sets for All: Home Construction Made Easy. Cr. 8vo. Pp. 78. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1923.) 1*s.* 6*d.**

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Cumming, A. C. The Manufacture of Hydrochloric Acid and Saltcake. (The Manufacture of Acids and Alkalis. By G. Lunge. Completely revised and rewritten under the Editorship of A. C. Cumming. Vol. 5.) Demy 8vo. Pp. xv + 423. (London and Edinburgh: Gurney and Jackson, 1923.) 31*s.* 6*d.* net.*

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Ephraim, F. Anorganische Chemie: ein Lehrbuch zum Weiterstudium und Handgebrauch. Zweite und dritte verbesserte Auflage. Roy. 8vo. Pp. viii + 742 + 3 Tafeln. (Dresden und Leipzig: T. Steinkopff, 1923.)

Fabre, J.-H. The Wonder Book of Chemistry. Translated from the French by Florence C. Bicknell. Demy 8vo. Pp. viii + 385. (London: T. Fisher Unwin, Ltd., 1923.) 10*s.* net.*

Fester, G. Die Entwicklung der chemischen Technik: ein technologisch-historischer Versuch. Pp. vi + 225. (Berlin: J. Springer, 1923.) 6*s.* 3*d.*

Holde, D. The Examination of Hydrocarbon Oils and of Saponifiable Fats and Waxes. Authorised translation from the Fifth German edition by E. Mueller. Second English edition. Med. 8vo. Pp. xix + 572. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 25*s.* net.*

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Sornet, R. La Technique industrielle des parfums synthétiques. Demy 8vo. Pp. xi + 135. (Paris: Gauthier-Villars et Cie, 1923.) 10 francs.*
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Dyson, Sir Frank, Under the Direction of. Astronomical and Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the Year 1918. Med. 4to. Pp. 7 + Axx + A49 + B13 + C3 + Dix + D147 + 5 + Exx + E80 + 18. (London: H.M. Stationery Office, 1922.) 45*s.* net.*
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